# Glockmaker

## BETA RELEASE

The making of DIY Glock 19 from scratch

Glock 19, 9x19mm

*A derivative of Glock 19 with minor changes for easier manufacturability without CNC machines*

*Home Workshop*
*Research Industries, Inc.*
*Rogue City, FGC*
*© 2021-2023*

# BETA NOTIFICATION

This manual format is assembled as a beta preview version, and contrary to statements presented in the header chapter, the file does not contain drawings or files or models of any presented designs.

The final file package will be assembled and released asap.

Date of first beta publication: March 20th, 2023

# An insight

Most homemade pistols have been rather crude designs, straight blowback and usually chambered in .380 or some other low powered cartridge to deal with the heavy bolt mass issue. Sophisticated modern era delayed blowback guns have existed for over a 100 years with little changes to the basic design, but they still remain out of reach of hand tooling due to several features that require close fitting parts and geometry – but perhaps most important of all, dedication and patience.

I was in mindset for a long that any gun that one would be capable of making as DIY would retain these characteristics. Any other than straight blowback design was just out of the question. Hence, I did not even look at more detailed designs, until I actually started to entertain the possibility of actually taking the task of making one. I played around with CAD models of Glock slide and a barrel, and the more I dwelled into details, the more I noticed how little it actually differed to make one compared to a relatively more simple design.

As an unexperienced hobby machinist with substandard equipment – literally the cheapest shit money can buy - I at first considered them to have a lot of intricate details that would be extremely difficult to replicate and keep all the tolerances in spec with relation to each other. However, the more I studied the parts the more I saw that every detail could actually be made using manual machining tools. I checked many dimensions of the CAD models to confirm they were actually in scale and true, including searching for exact dimensions from official sources, from user posted content, comparing to constants such as cartridge and chamber dimensions, and even took approximate measurements from pictures by calculating the scale from actual pixels divided to known actual dimension. There were also partial blueprints in PDF form, and when I found out that everything checked out, I used the CAD models to make a set of drawings – which are included – and went to my workshop.

For the first pair of slide and barrel, I used some methods which I further refined later, as they included a lot of manual work with big margin of error, such as hand filing the breech slot, and I made a couple of mistakes, but I managed to recover the parts. I used the old school method of hand fitting the parts along with the actual specific dimensions, but when I later made more copies, the parts were interchangeable, so the final dimensions were pretty much in spec. And behold, after perhaps about 100 hours of total work, I had a fitting pair of slide and a barrel, and apparently I got lucky as everything fitted together by the first try.

The firing pin hole is one of the only details I have changed. The original Gen3 firing pin hole is square, as is the striker, but replicating this type of opening without micro broach or EDM would be very challenging with high risk of failure, so I decided to go one step further, and fabricate the striker myself, and hence I could use a plain round firing pin hole. For home workshop based manufacturing capabilities I believe this solution is a much more accessible, and it should not compare too badly, because Gen5 Glocks do tend to have mostly round firing pin holes as well. Another benefit is that strikers are pretty expensive being so small parts, hence making one saves actual money.

I printed a frame based on PY2A design and reverse-engineered a set of rails based on their models. I had difficulties making those rails at first, as all bending attempts failed miserably, and I ended just cutting the rails into two halves and hand fitting them. The front rail block was successful, however it required quite a lot of work to machine it, so I refined the rail design and swapped it into two separate rail inserts that were pinned in the frame. I also made a locking block, as it's the second most expensive small part after striker, but not as difficult to make as it initially seemed.

After making and fitting all these parts, I got a set of rest of the small parts, and everything worked, the gun cocked and dry fired and ejected. The first genesis model slide was made from mild steel, but after doing a test part, I made a functional part from prehard 4140. This gun was test fired first with two low-end chart loads, and after function was confirmed, the gun was proofed with two chart maximum loads, and no signs of issues were observed.

I was personally extremely surprised that I was able to fabricate an entire Glock 19 that functioned. The confidence I got from that trial was such that I was highly motivated to push forward new projects and I no longer saw precision machining and complex parts an issue, but a challenge that could be overcome. Actually, I think currently that it is easier to make a Glock style pistol than a simple straight blowback gun, because the design itself is sound and proven, and due to it's mechanics, it applies relatively little stress to the frame, unlike fixed barrel guns, so it is likely much better suited for 3D printed frames. The complexity of a straight blowback slide, being telescoping in nature, can be equal, or worse even more complex to fabricate than a tilting barrel slide, as the general features such as barrel pocket, recoil spring mount, breech, firing pin and extractor, feed geometry and others are basically the same.

As people showed great interest, I considered it would be a good idea to write down everything in one manual, hence Glockmaker was born. I have included in this manual every detail I have had to deal with, and also most other parallel skills, from basic machining and metalworking to the very core of metallugy and heat treatment of alloys to actually make something useful and durable from steel, so people generally interested in basic and DIY gunsmithing could benefit from the content as well for that part.

With this manual, the parts that has to be purchased will come down to absolute minimum. There are some parts that I have studied on, but not made any actual tests, so I include all of these parts with caution to be used as reference information only. Parts that I have not made are are recoil spring assembly, trigger bar, extractor and trigger itself.

Although I will write down the procedure I used to fabricate the first iteration, I will also include along that the more sophisticated methods, that include dedicated tooling, which suit for making multiple parts. Examples of these tools are the barrel lug slot profile cutter, which can cut the locking block odd-profile slot with one pass, and a broach, that is used to form the breech by first pre-drilling and milling out the ejector slot to the slide blank. These tools should last long when treated properly, so if more copies of consistent quality are intended to be made, a lot of attention should be given for tool preparation.

The composing of this manual differs slightly from the MPC manual, as I have chosen to take more broad and free approach describing all the details along the way. I have attempted to visually record everything, but I have had certain restrictions which prevent the free photodocumentation of the entire process, and also, I already made a series of all of the parts listed before deciding documenting the process, so not all parts may be necessarily documented to every exact extent.

The file package contains the full blueprints and CAD models for all major parts but excludes some small parts, as the project files I have are not dimensionally verified, but with this data, a willing and interested person should be able to replicate the build and obtain a Glock 19 with only few spares to be bought. The work descriptions have been written with good will, but may not be exact and may contain errors, so while the drawings presented have used to fabricate the parts described, it is not granted that every person capable of reading this manual is able to replicate the work.

This manual is not "Glock for dummies", but rather a manual how to manufacture a handgun without expensive tooling in a repeatabe manner. The build will require basic knowledge of metalworking and access to a manual lathe and a mill with basic accessory, and limited education is provided in this manual. Effective gunsmithing of advanced gun parts is something I deem prohibitively slow and complicated without basic machine tooling, so zero emphasis has been given to "Glock-like" guns, and manuals for these types of designs can be found online if the build is desired unattainable at the moment. Also, shortcuts are not being taken and are highly advised against, unless the user excels in gunsmithing and metallurgy, although unlikely being interested in this manual in the first place.

The spirit of this manual is to learn full extent of gunsmithing and discourage guns that are deemed "DIY" but are nothing but downloadable plastic skins with need to purchase parts kits of existing commercial guns, or custom built designs. This is an exclusive privilege of The Free People of The United States, but practically every single person outside of that benefits none of kits and builds, but are in need of complete solutions. These "skull and cock" - type gun kits are not just useless, but even detrimental to actual development, as they dwell into useless and bogus designs that are not designed in the first place to be rugged and useful utility guns, but toys intended for range fun or to be displayed as a cosplay or other purposes that are not small arms related.

Gunsmithing is a challenging and a time-consuming art, ultimately having no difference at all to any other forms of art, such as watchmaking, but once the capability is developed, the dependence on regulations and restrictions is eliminated. My personal motivation behind gun designing, apart from enthusiastic interest in gun mechanics, is to collect, research and develop data that may be useful for making independent builds, and pass this information to the interested audience, and being an avid supporter of the 2nd Amendment of the Bill of Rights of the Constitution of the United States, consider it positive if the people are able to learn new details about gunsmithing and get inspired of making their own.

AP358,
Home Workshop Research Industries, Inc.
Rogue City, Fuck Gun Control

My other and previous works:

- MPC, 9x19mm straight blowback PCC (development has ended as the design was considered obsolete when better versions were developed)
- SPC, an advanced version of the MPC, smaller and more sophisticated, under works, first prototype completed and test fired
- MRC, a .300 Blackout rotating bolt automatic rifle, with 5.56mm compatibility, under works, first prototype almost ready

Also, on a concept level, a flapper locking rifle based on .338 Ulfberht, 9x19mm Musrgave semi-automatic pistol, 22 caliber semi-automatic pistol, a pen gun, and a bullpup version of the MRC rifle have been on the works.

### Contents and attachments

- *STEP Assembly of a Glock 19 derivative with most parts included*
- *3D printable jigs for machining specific angles and shapes*
- *Special cutting tools drawings and instructions required for certain steps*
- *SpringFactory V1.1 for manufacturing magazine springs*
- *Rifling tool plans for button rifling and blueprints and instructions for making a button*
- *A basic compact wiped suppressor design*

## Content info

All part dimensions are mentioned in drawings ONLY to avoid cross-reference mistakes. In case any numbers are given in description, they should always be checked from drawings and any conflicting values must be presumed true in the drawings.

The manual describes the development, assembly, manufacture and fitting of the gun. Also are attached chapters about general metalworking, heat treatment, materials sourcing and other information that may be deemed useful.

What the manual IS NOT is a how-to-do a Glock for idiots.

The file package with this manual includes the entire Glock 19 assembly in a STEP file. The user can export these files into necessary formats. A file that contains instructions and details that were used to print the frame(s) seen in this manual are included for replication purposes.

Tooling drawings for special cutters needed are included, as well as 3D printable jigs and angle plates required for making the parts.

## Disclaimer

The methods presented here warrant at least basic knowledge about machining and metalworking. The general tooling, such as drills and mills required are not separately specified, and only the special cutters that has to be done on site are described. There may be ways to manufacture a part other that are described here which are better. The reader is presumed to be experienced in safe practices and methods. The gun in this manual is not intended to be manufactured in the same concept as with the FGC-9 is, but it is targeted to a more experienced audience, with the shining example of Bill Holmes' productions, and with the goal of replicating a functional pistol that is easy to manufacture with limited resources and with minimal parts that may be limited in availability due to specific reasons. By far the most complex parts to manufacture are the barrel, and the slide, but it is the intention if this manual to demonstrate the feasibility of the manufacture of these parts in good quality and appearance if the user has even basic metalworking knowledge.

All chemical reactions and treatments, including but not limited to surface finishes (bluing, parkerizing) will warrant basic knowledge of the properties of any chemicals involved, and use of necessary PPE. Strong caustics and acids are effective tools and safe when handled properly, but will result in permanent blindness upon eye exposure and will also corrode skin and all other reactive materials. Full coverage safety goggles are mandatory. Breathing in corrosive or toxic vapors (ammonia, cyanide salts) may cause permanent damage and instant or latent death. Materials compatibility must be checked if not specified. If any energetic materials are handled, e.g when reloading ammunition, proper safety measures must be carried out.

Warning! Small arms are designed and built to be weapons of war, and must be operated under strict safety protocols. Jurisdiction may vary, and special procedures on obtaining, manufacturing, possessing and storing the parts described herein may exist. The reader presumes all responsibility for the use of the information, which is provided for academic and learning purposes only.

## Table of contents Page

1) **Tooling**
2) **Barrel**
3) **Slide**
4) **Striker**
5) **Locking Block**
6) **Slide Lock**
7) **Rails**
8) **Extractor**
9) **Frame**
10) **Markings**
11) **Finishing**
12) **Suppressor**
13) **Technicals**

# 1. Tooling

This chapter lists all the required tooling for making the parts. All tools are listed uniformly, and it is left to the discretion of the operator to choose which tools to buy and which tools are made in shop. Common mills, drills and reamers are generally exclusively purchased, but custom tooling must be prepared.

It is noteworthy that many of these tools are not essential for minimal function, but they provide fast, uniform and clean looking finish for the steps involved and are beneficial if multiple parts are made. In most cases, they can be substituted with ordinary end mills, drilling, sawing and filing, but the skills of the worker will play a major role for the outcome and finish.

## Drills

*Note: It is highly recommended to use HSS-Co / M35 cobalt alloy drills for prehard and alloy steels, because these drills are usually made to higher quality spec (ground instead of formed) both harder and sharper and retain edge longer and are more resistant to heat. For roughing large, shallow holes ordinary HSS can be used, especially if the finish size is either radial milled, bored or reamed or is of low importance hole that will be permanently covered.*

- 2 mm, 3 mm, 3.5 mm,
- 4 mm, 4.5 mm, 5 mm
- 7 mm, 8 mm, 8.5 mm
- drills of stepped size if needed up to 14.5mm (can be normal HSS for cost cutting)
- 3.5 mm minimum 150mm LONG
- 8.5 mm minimum 120mm LONG (8.5mm gun drill preferred)

## Mills

- 4 mm carbide
- 6 mm carbide
- 6 mm carbide R0.5 bull nose (OPTIONAL)
- 7 mm HSS
- 9 mm HSS
- 10 mm HSS
- 12 mm HSS

NOTE: It is recommended to have 4mm and 6mm mills in normal type and bull nose with R0.5 radius. These are used to do the finish pass for the last 0.5mm at 0.25 to 0.5 layer depth depending on size of the machinery being used. Sharp inner corners should be avoided at all times whenever possible, especially if the part area is of high stress, or very much so if it is to be heat treated after machining, as these sharp corners will form stress raisers, which can cause the part to crack right away, or during use, possibly catastrophically.

- Fly cutter or 30mm face mill with carbide insert for large facing

## Profile cutters

- 45DEG chamfer cutter / center drill
- 60DEG chamfer cutter
- R 5 mm radius cutter (For rounded slide ONLY)
- R 0.5 mm radius cutter
- Slot mill, 1.5 x 6 mm
- Slot mill, 2.5 x 10 mm (or 2 x 10mm)
- Rear sight dovetail cutter
- 45DEG forming tool for breech broach
- Striker channel profile reamer
- 45DEG cutter for barrel chamfering
- 24DEG slope cutter, for forming barrel breech
- Lug hob, for forming barrel locking lug
- Serrator hob, for slide side serrations
- Recoil spring mill, for barrel recoil spring face
- Lock hob, for forming slide lock serrations
- Pin former, for forming firing pin head

## Reamers

- 4 mm min 80mm LONG
- 5 mm min 80 mm LONG
- 6 mm
- 7.5 mm
- 8.8mm carbide or carbide tipped HSS min 120mm LONG
- 14.7 mm tapered reamer for barrel angled hole

## Accessory

- Depth gauges for drills as required, unless DRO or other measuring method is available
- M8 threaded rod, with shaft turned down to 7.5mm for recoil spring lip radius milling, with 4 x M8 nuts

## Custom tooling

- 3.5 mm D-bit drill or a gundrill min 120mm LONG
- Optional: 8.5mm gun drill or d-bit for substituting 8.5mm M35
- 4 mm broach for finishing extractor slot
- Breech broach
- 5mm round bar, with 2mm hole drilled to 15mm depth, and cut 2mm drill bit inserted in, using epoxy glue, with 5mm MAX protrusion
- Steel insert for plunger jig
- Rifling button with press (or ECM)
- Chamber reamer, 9x19 mm CIP/SAAMI
- Recoil spring counterbore tool
- Crowning tool, for barrel muzzle
- Radius jig mounting bolt (for rounded slide ONLY)

## 3D printed equipment

- 6 DEG Angle block
- 10 DEG
- 15 DEG
- 20 DEG
- 30 DEG
- Tilt jig 10, for barrel hole tilt angle forming
- Plunger jig 3, for extractor plunger channel drilling
- Port jig 45, for ejection port angle milling
- Extractor jig 30, for extractor slot angle milling
- Vent jig 30, for drilling striker vent hole at an angle
- Chamfer jig 45, for milling slide corner chamfers (for chamfered slide ONLY)
- Bushing for crowning tool
- Thread protector to barrel for tumbling
- Barrel plugs for tumbling
- Radius jig (for rounded slide ONLY)
- Rail jig, for milling rear rail radius
- Chamber hone
- Channel hone

## Heavy tooling

- Mill with DRO
- Lathe with 4-jaw independent chuck
- Hydraulic press
- Riflepress assembly for button rifling
- Angled vise or a method to hold parts at an angle horizontally within +-1DEG
- Square collet block
- Rotary table (optional against collet block)

# 1. Tooling

## Notes for cutting costs and simplifying process

- Slide serrations can be cut using ordinary 3mm end mill and their amount can be reduced to OEM spec.
- Striker channel can be formed through drilling only, but the hole must be bottomed with a flat drill
- Fly cutter is not essential, but will speed up facing a lot and provide superior finish
- Chamfering can be done using normal chamfering tool and depth of chamfer can be reduced
- Slide breech can be formed by filing only, increasing time and handwork a lot
- Barrel crowning tool can be substituted with chamfering tool
- Barrel lug can be formed through drilling and filing
- Firing pin head can be formed by filing

# 2. Barrel

The barrel is made from 4140 or 4340 steel that is tempered to around 40HRC. The exact hardness may vary between 35 and 45, which is suitable for pistol barrels as is. A directly suitable alternative, 4340 at 40HRC, which is both harder and tougher but can not be hot blued. Other types of steel, such as 440 and 17-4 stainless series, S7, L6, H13 and similar steels can also used, but they are not established in this manual.

If desired, a rifled barrel blank for 9x19mm can be used, so the boring and rifling steps can be skipped.

While rifle barrels remain of lower hardness, generally between 26-32HRC, pistol barrels, bearing lower pressures, are made harder to accommodate the pressure in thinner sections. Indeed, the chamber has wall thickness of only 2.7mm at it's thinnest section, and based on the original design, the barrel was still able to withstand 5000bar double load test discharge during OEM Glock trials.

To manufacture a barrel, a suitable material is obtained in 30mm round stock. The surface finish is irrelevant, so cheapest "black" condition can be preferred. The material usually comes hot drawn in quenched and tempered condition (Q+T), but it is also supplied in peeled and ground, which is commonly more expensive. It is important to check the material specification before purchasing to make sure the heat treatment is correct. Annealed 4140 may not withstand the pressures, and it will deform under use very quickly because the surface pressure of the locking surface exceeds the material yield strength.

A threaded barrel manufacture is described here. A threadless barrel shares every exact dimension except the thread, so a procedure excluding that step can be used as is.

If the barrel is rifled with ECM technology, the rifling can be done at any point desired. When button rifling, the process order is critical. The bore must be drilled first, and then rifled, because rifling buttons require enough wall thickness to form the threads properly; too thin walled tube will have a lot more springback due to deflection, and a superficial rifling may result; also, too thin walled tube may simply bend under the press. In this manual, button rifling is utilized, and if ECM is desired, manuals and tools are available online.

**Drilling and boring**

The barrel is drilled using commercial HSS-Co twist drills of standard or extended length. It is typical for the hole to appear slightly off center from the other end, but this is of no concern as the barrel is trued to the bore by turning between centers after boring operations have been completed. Twist drills are therefore well suited for pistol barrel production. Proper drilling technique is to use moderate rpm and pressure, sufficient lubrication with EP-80W-90 GL-5 oil (from here "ep oil") and step drilling with minimum of two steps to eliminate burrs by minimizing final pass chip load. A proprietary gun drill can be used if available.

A stock of 4140QT (1100MPa, 38HRC) is cut and faced to length and center drilled. A pilot hole with 4mm extra long HSS-Co twist drill is drilled through. Hole is started with lower rpm and slow feed to ensure straight start, and rpm is increased after drilling first 10mm. Drill is retracted after every few mm of drilling to remove chips, and cutting fluid can be applied to the tip using a small brush. There should be no noticeable heat produced during this operation. The hole is enlarged to 8mm, and finished to 8.5mm with sharp drill, sufficient lubrication and slow, controlled feed to assure no burrs are formed.

An 8.8mm reamer, preferably carbide, is used to carefully ream the hole to spec. Lot of EP oil must be used, and the hole and the reamer must be frequently cleaned of chips. Pressurized air or a bore brush will help.

PICTURE OF DRILLING PROCESS

When the reaming is complete, the bore is checked and should appear uniform and smooth. Reaming will produce smooth, uniform round hole that looks ground, but does not have mirror finish. Carbide reamers provide superior surface finish.

### Button rifling

PICTURES OF RIFLING STEPS

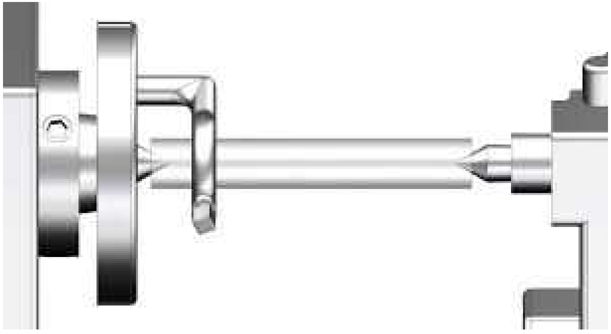
The barrel blank is immersed in hot detergent bath (dishwashing soap will suffice) and scrubbed with bore brush to remove any dirt, chips and oil. After this, the barrel is dipped in acetone to degrease it completely.

A bath of copper sulfate ($CuSO_4$) is prepared by adding 100g/L (concentration is not critical) of $CuSO_4$ to enough warm water to immerse the blank(s) and stirring until dissolved and clear blue solution is formed. The acetone rinsed, clean and dry barrel is fully immersed in the liquid, with occasional stirring for 5 minutes. After this, the blank is carefully rinsed with water to remove any $CuSO_4$ residues. Some copper may flake off the surface. Let drip dry, no further drying is necessary. The purpose of this procedure is to precipitate metallic copper on the surface of the bore, which will act as a solid lubricant upon the pressure exerted by the rifling button.

Into the bore, a few CC of copper or molybdenum disulfide grease is applied, and the blank is inserted in the blank holder of the rifling press. A rifling button, smeared in the same grease, is placed on the mouth, and the press rod is carefully placed on top, and the button is pressed until flush with the barrel end. The concentricity of the press rod is carefully checked, a 3D printed centering jig (included with rifling press plans) can be used for the purpose. If not centered properly, the press rod can scratch the barrel surface.

The button is pressed constantly through the barrel, avoiding stoppage, and when resistance drops at once, the button has been pressed through. If large increase in required force occurs at any time, stop immediately and investigate the issue. The barrel is wiped clean, piece of paper towel is pushed through the bore using soft rod, and brushed using bore brush and WD oil, and the bore is checked visually for satisfaction.

### Turning between centers



Turning between centers trues the barrel outer surface to the bore and removes any potential eccentricity occurred during boring process. If visible eccentricity is noticed, this end should be designated as the barrel muzzle end, so the chamber block will have full stock material available for machining; usually the drill exit side is slightly off due to drill wander. If the muzzle is to be threaded, the breech stock should be skimmed to the absolute minimum to preserve as much material as possible while still ensuring the barrel mounting to the chuck during threading is concentric. For non-threaded barrel, the stock can be left black.

Both ends of the rifled bore are chamfered to create mating surface for lathe center. The muzzle chamfer will carry over and will be trued in the final phases. Only minimal chamfering is necessary, as the tool pressure will be minimal for this small work.

The barrel shaft is turned to spec, and muzzle thread profile is turned. The shaft is turned with allowance of

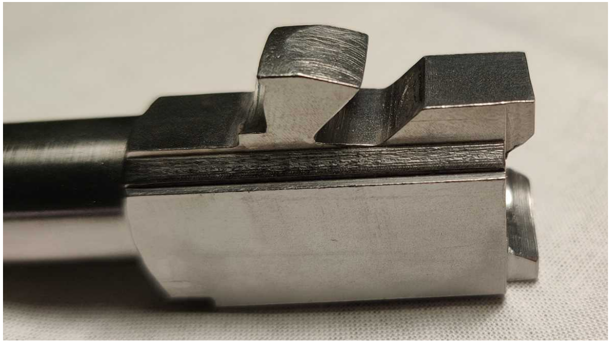
0.1mm, and ground and polished to final size using file and set of sandpaper and scotchbrite. The desired surface finish is ultimately left for the user to decide as long as the shaft is in spec.

**Muzzle threading**

After the barrel shaft and thread profile blank is finished, the barrel is detached, and mounted in a chuck and dialed in to true the shaft. In case the lathe is capable of cutting threads as is, it is preferred means, but in case a thread die is desired, a trued round stock is clamped to the tailstock, and the thread cutting die is pressed against the barrel using this stock and threads cut using EP lubrication with good thread cutting practices, until full form thread has been cut. If burrs can be felt, the thread can be deburred using sandpaper.

**Milling the chamber block**

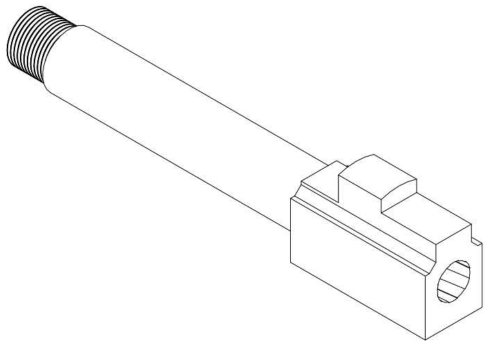
After threading, barrel is clamped to square collet block from the shaft. **The barrel remains clamped in the collet until de-mounting is stated specifically.** The barrel blank is indexed using the collet block, and removing it will skew this alignment.



Using DRO, all the reference dimensions are measured from the barrel shaft, so enough clearance for probe must be left. Reference for center is made with halving command, and height to bore centerline is done by dialing the cutter with thinnest available feeler gauge to the shaft, and deducing ½ of the barrel shaft diameter from Z-axis and zeroing.

Unless a high grade collet block and vise is used, the blank must be dialed in every time it is re-mounted. Cheap collet blocks can have error of 0.25mm or even more.

A rotary table, unless tilting, can be used instead. However, the angled surfaces have to be milled separately using vise clamping indexing to the chamber block.



The chamber block is milled by using desired cutter, that can be an end mill, face mill or a fly cutter. All surface dimensions are referenced to the bore centerline. Allowance of 0.05-0.1mm to sides and top should be left for surface sanding. With mill, preferably using larger, minimum 10mm carbide end mill, the top and sides can be milled in a single mounting, but with small machines rigidity may be an issue.

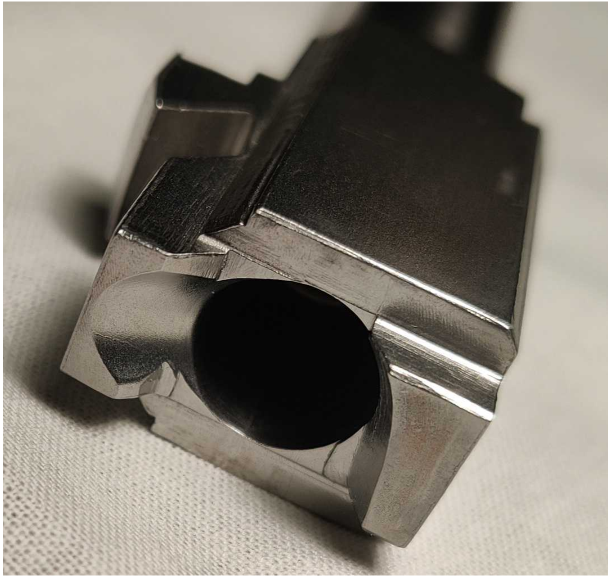
# 2. Barrel

At the bottom, only all vertical surfaces are milled.

Custom cutters are used for milling the sides at 45DEG angles. These angles line up with the locking block.

The collet block is mounted vertically, and the breech area is milled to spec.

**Feed ramp**



After the general shape has been formed, the feed ramp is milled using 45DEG angle block. Further, the feed ramp rounding is done by plunging with endmill using 37DEG angle block.

Feed ramp must not be milled any deeper than spec, as it will create an unsupported chamber, that may cause a blowout.

**Breech relief milling**

Pic of relief milling

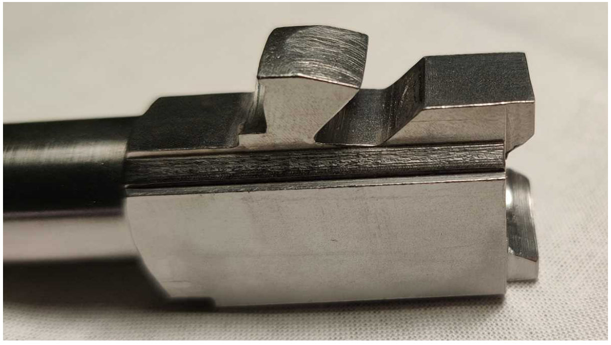
The barrel is mounted vertically on an angled vise, and using breech slope cutter, the breech relief slope is cut. The tool is plunged level to the face of the chamber block, and the slope is milled. Care must be taken not to damage the feed ramp.

Bottom angles

The bottom angle and slot, that locks the upper assembly to the frame by mating with the slide lock, is milled to spec using 2mm slot cutter and an angle block.

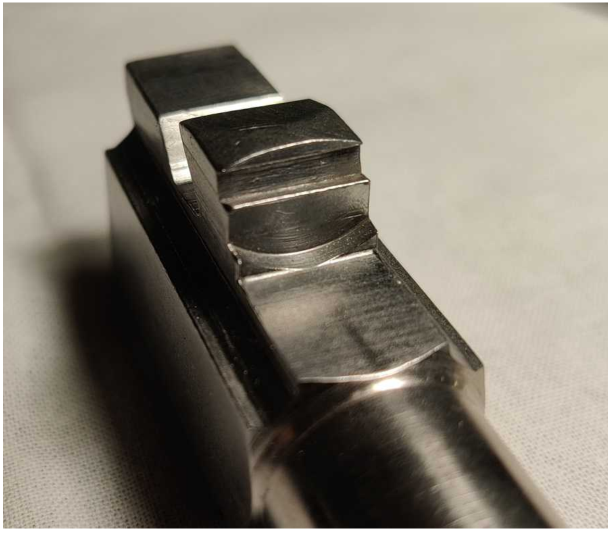
**After this, the barrel can be removed from the collet block.**

**Lugging**



The barrel is mounted directly to a vise using 45DEG angle block. Using barrel lug hob, the barrel is indexed, and the locking lug slot is cut by plunge milling using low rpm and lubrication.

**Recoil spring slot**

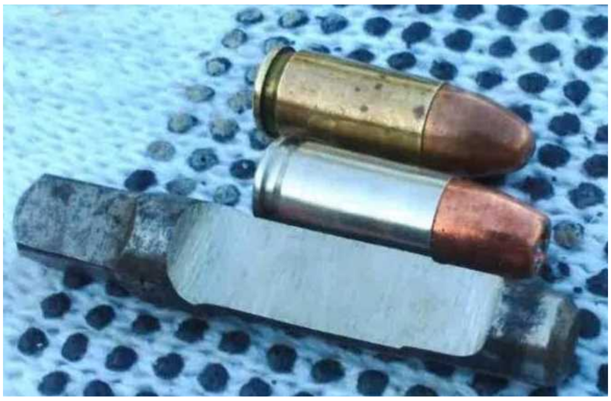


The barrel is mounted vertically, chamber block down, and using recoil spring slotting tool, the slot rounding is milled carefully due to large overhang.

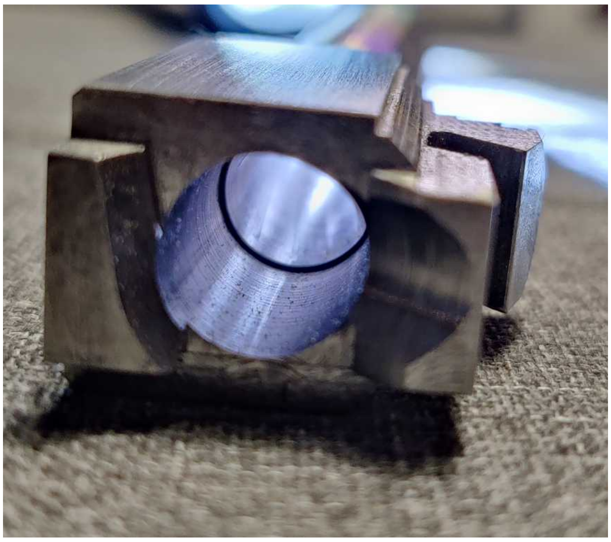
**Chambering**

# 2. Barrel

Final step is chambering the barrel. A suitable chambering tool can be made from D-bit reamer by turning a drill rod into the desired caliber's standard chamber dimensions and by carefully removing 50% minus a thou of the material of the diameter of the cutter. This tool is then drilled into the barrel with generous lubrication, and frequently removing chips to prevent them scraping the surface of the chamber. The feed rate is kept very slow, so that the chips will come out more as a metal sludge than actual chips. Over the process, a cartridge or a go/nogo-gauge is tested.

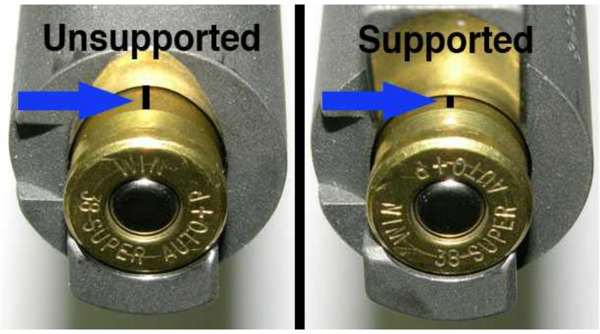


Commercial chamber reamers do exactly the same job, but faster and usually more precisely. In this context, superior accuracy is not necessary, so the exact aligment of the chamber is not critical and no floating mount is necessary, as long as the cartridge sits deep enough, and it can have a snug fit, as the chamber is ground after reaming. Commercial reamers usually produce better surface finish. However, most chambers are ground to final finish, so less than ideal surface finish to start is not an issue. Reamers are supplied in two forms, roughing and finishing reamers. Roughing reamers are usually involved with bottle-necked calibers that require a lot of material to be removed and used for mass production and fast pre-forming in order to save the finisher which produces the final precision chamber, but for non-industrial use, a finishing reamer is well enough, and used properly it can ream at least a hundred barrels with ease.

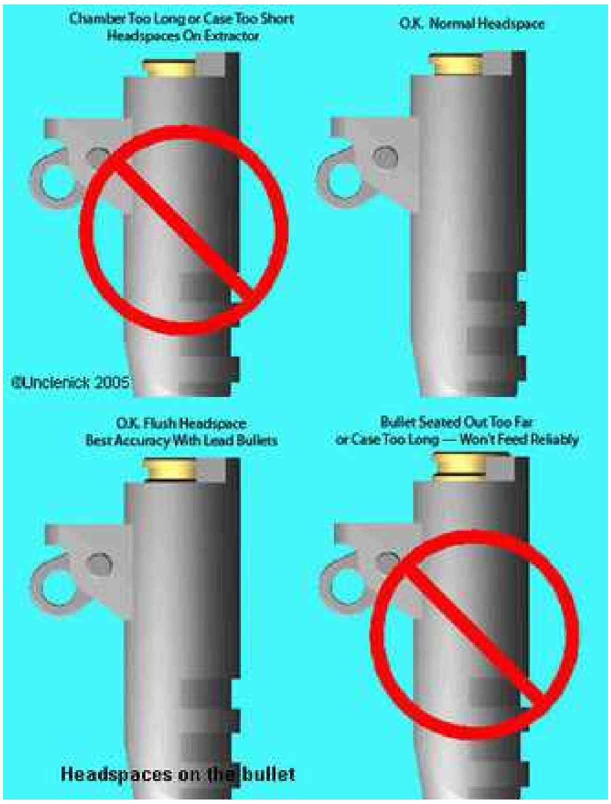


Barrel after chamber reaming, before polishing. Burrs are clearly visible, and the chamber is rough. It will work in this condition, and would actually be beneficial as bolt thrust is significantly reduced due to greatly increased friction, however this may cause feed or extraction issues and makes the chamber more prone to fouling and jamming in case there is any foreign matter or the ammo is not properly resized.

If no gauges are used, a new or sized brass can be used instead to match the headspace. It is important to use resized brass or unfired brass, because fired brass will always carry over the chamber spec of the gun that it was fired with, and it will likely not fit at all into an in-spec, tight fitting chamber. This impression can result in oversizing a barrel, resulting in various issues, such as light strikes and jams because the cartridge can slip too far into the chamber and can not be removed by the extractor at all. If managed to set off, the back of the case will immediately impact against the breech, and this may completely shear off the head of the casing, resulting in

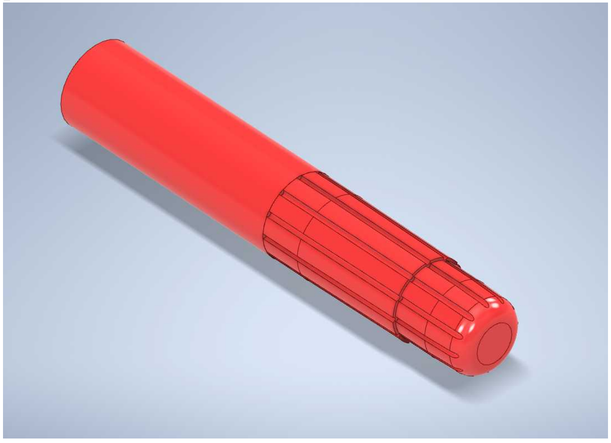


much more catastrophic result than mere blow-out. Hence the seating depth definitely can be too deep as well as too shallow. Proper seating depth is flush with barrel top breech block.

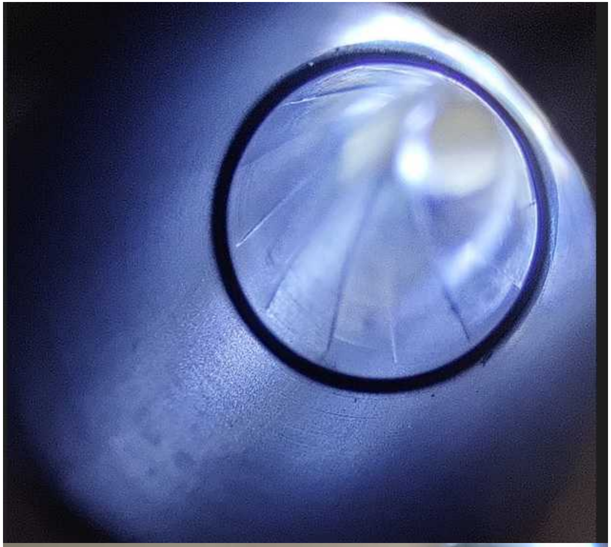

Chamber Too Long or Case Too Short
Headspaces On Extractor
O.K. Normal Headspace
©Unclenick 2005
O.K. Flush Headspace
Best Accuracy With Lead Bullets
Bullet Seated Out Too Far
or Case Too Long — Won't Feed Reliably
Headspaces on the bullet

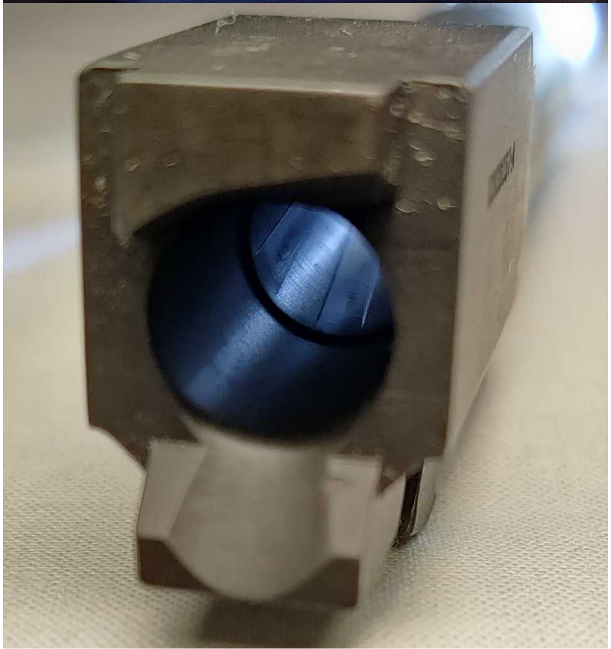
Due to the feed ramp design, Glock, 1911 and most other self-loading pistols have what is called a partially supported chamber. This shows as a distinctive bulge pattern in fired brass in some guns, such as Glock and 1911 designs. This is generally regarded as acceptable, and such small bulging does not significantly increase a blowout risk.

After the headspace is set, the chamber is polished using fine sandpaper on a dowel, which can be substituted from anything, from wooden pins to drill shafts. Sandpaper is wrapped around the shaft, starting from 240 grit and 400 grit, and a drop of oil is applied, and the chamber is honed and checked frequently, until the burrs have smoothed out. The process is repeated with 1000 and 2000 grit papers. The chamber is finish lapped by using included 3D printed honing tool and polishing paste.



After polishing, the chamber should appear glossy and free of any significant burrs.





# 2. Barrel

### Deburring and polishing

Excess burrs can be removed manually with needle files and sanding. Chamber block should be surface sanded smooth from every surface until cutter marks disappear. After this, a bore protector (file included, or a suitable silicone rubber conical stopper) is inserted to plug the bore from both ends. The barrel is then either tumbled with porcelain media, or sandblasted.

Feed ramp polishing will improve feed reliability. Rounding of the edge between feed ramp and chamber should be done with caution and using only fine grit in order to not create unsupported chamber.

### Surface treatment

Hot bluing and parkerizing are described in detail in their own chapter, hence no further details are given here. Barrels are blued without plugging the bore, as high heat will cause pressure buildup. The applied coating is so thin it will have no effect on bore and will wear off during normal use.

Finished part, after hot bluing.

### Proofing the barrel

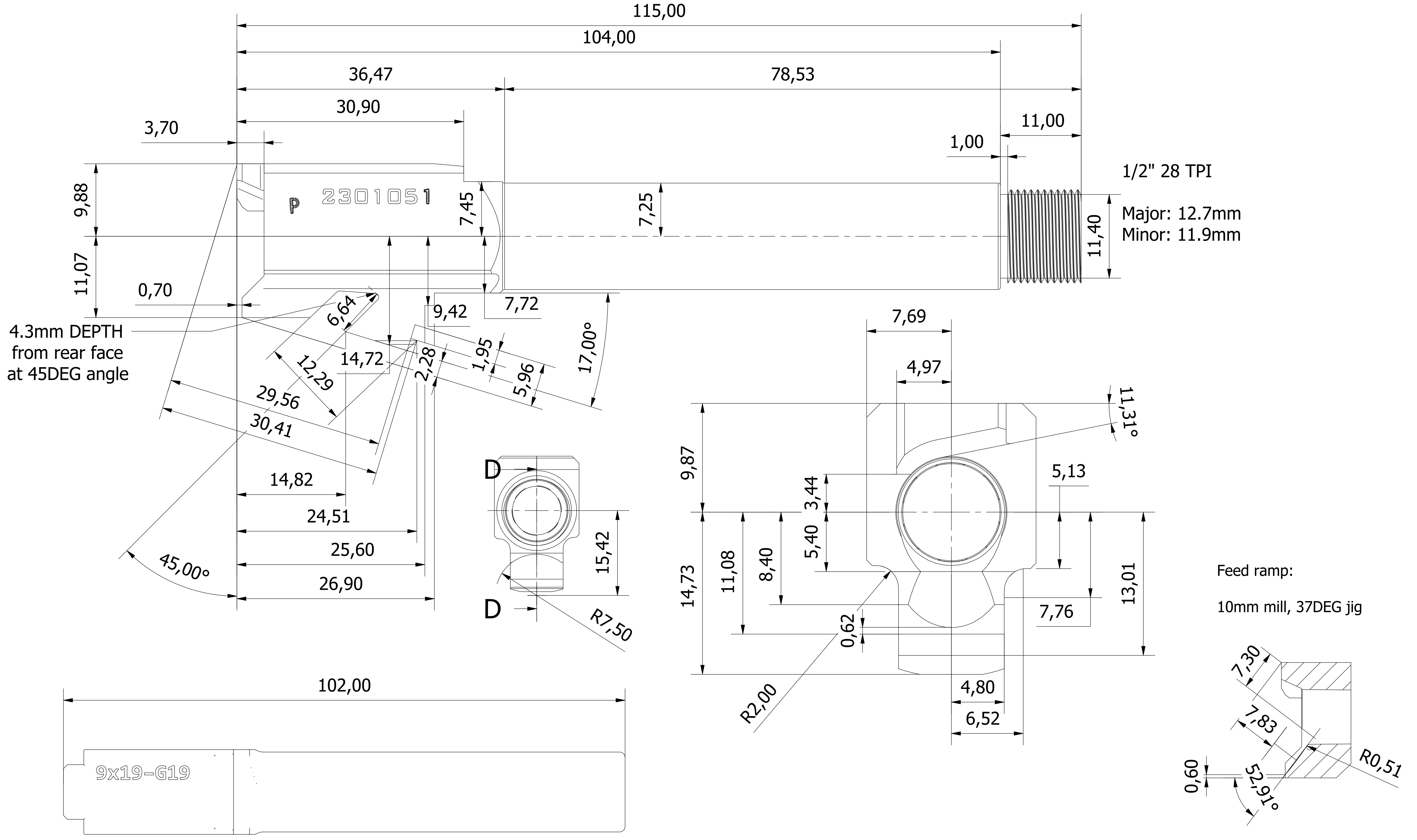
If the barrel is proofed using 30% overpressure cartridges according to CIP test, the barrel equals to commercially supplied barrels and can be freely used for any commercial 9x19mm loads available. The CIP test involves remotely firing two (2) overpressure rounds with 30% excess chamber pressure.

Loading chart example for CIP proof load:

Use +P+ loads, 9mm Major, high end chart loads, for example refer to:

[http://www.natoreloading.com/9mmmajor/](http://www.natoreloading.com/9mmmajor/)

It is recommended practice to first fire two low-end chart pressure rounds to test the basic function of the gun. After successful firing, two high-end 9mm major loads are used, if no specific proof rounds are available.



Threadless barrel identical excl. OAL

| Designed by | Checked by | Approved by | Date | Date |
|---|---|---|---|---|
| HWR | | | | |

G19 Barrel

Edition

Sheet 1 / 2

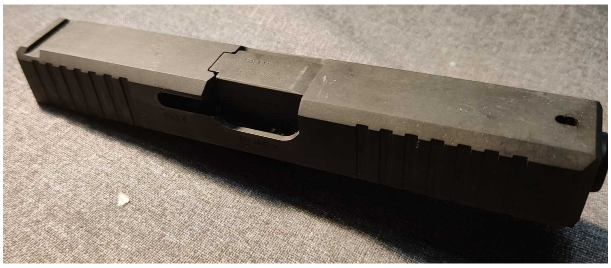
# Barrel, Glock 19

Material: 30mm round stock, 4140, 4340, 40HRC

1. Part OAL w allowance
2. Drill, ream bore to 8.8mm
3. Button rifle
4. Chamfer for turning between centers
5. Turn barrel shaft to spec, grind polish, chamfer muzzle
6. IF THREADS: dial true to chuck, tap thread
7. In square collet block, index, mill sides, top
8. Mill frontal step
9. Mill top chamfers using chamfering tool
10. Turn, mill bottom sides
11. Mill 45DEG using profile cutter
12. Mill bottom profile
13. Turn upwards, mill breech shape, recess feed ramp
14. Mill feed ramp profile at 45DEG angle
15. Plunge mill feed ramp with 37DEG angle
16. With angle plate, using slot cutter, index distance to breech, height to feed ramp, mill bottom ramp, mill locking slot
17. In angled vise, mill breech slope using profile cutter
18. Dismount from collet block
19. At 45DEG angle, barrel up, mill lug slot
20. Mill front step relief
21. Mill recoil spring slot
22. Deburr, surface sand faces.
23. Clamp barrel plugs with M4 allthread.
24. Sandblast, glass bead blast.
25. Hot blue or parkerize.

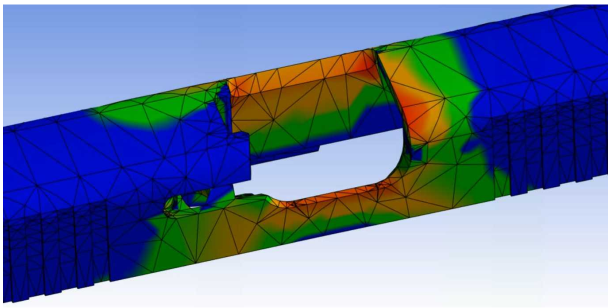
| | | | | |
|---|---|---|---|---|
| Designed by<br>HWR | Checked by | Approved by | Date | Date |
| G19 Barrel | | | Edition | Sheet<br>2 / 2 |

# 3. Slide



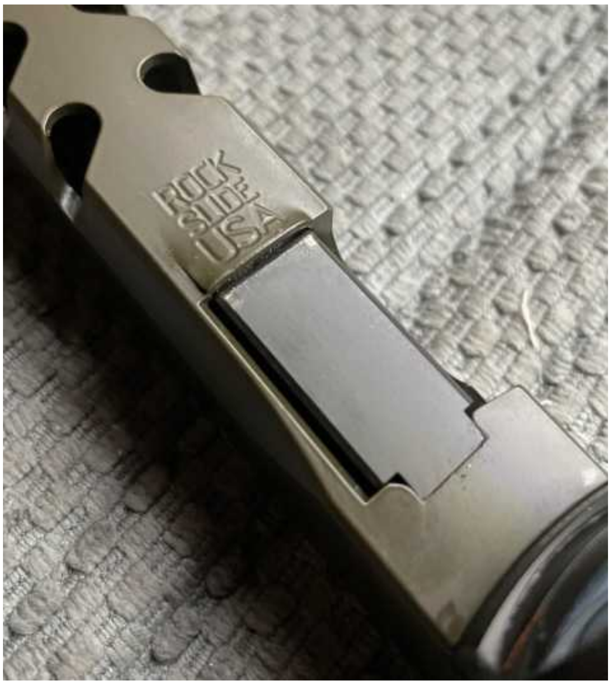
Picture of finished, hot blued 4140 slide that has been proof tested and completely ready for use.

The slide is the largest and most complex part of the entire assembly, but machining it is not as difficult as one may initially think. In order to avoid heat treatment step, the slide is manufactured from same material as the barrel, from pre-hardened 4140, that is well machinable up to HRC40, but resists wear and is tough to withstand the shock loads.



The stress points of the slide are the breech and the front surface of the ejection port. When the gun is fired, the case head of 9x19mm generates about 2 tons of force against the breech, and as the slide is locked around the barrel, this force is transmitted to the barrel via the front edge. This edge has surface area of about 37mm2, hence the force divided to area is 54kg/mm2.

The 4140QT used has yield strength of about 100kg/mm2, so the material can easily withstand this stress with a large margin. Typical cold drawn mild steel, for example 1020/S355, has yield strength of 35kg/mm2, so a slide made from this material would start yielding from the very first shot, and the gap between barrel and slide would widen, until it grows so large the headspace of the gun causes a case rupture. However, case hardened mild steel or 1045 equivalent medium carbon steel can be used without issues, as long as the material is heat treated properly. For more information, refer to Technicals chapter.

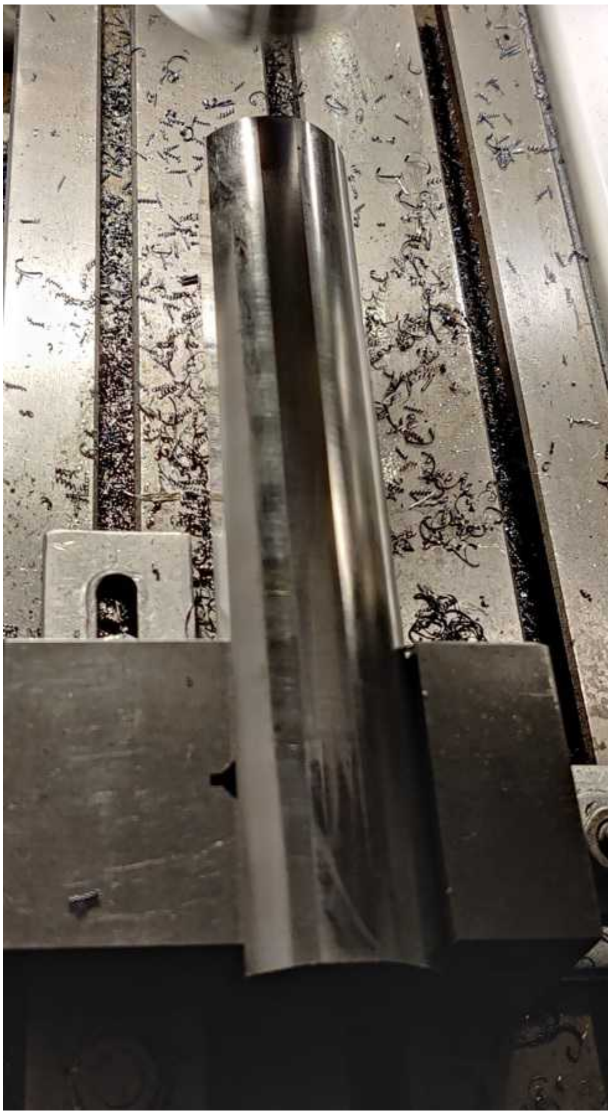


***Yielding.*** *A typical failure mode for mild steel or unhardened alloy steel.*

**Making the slide**

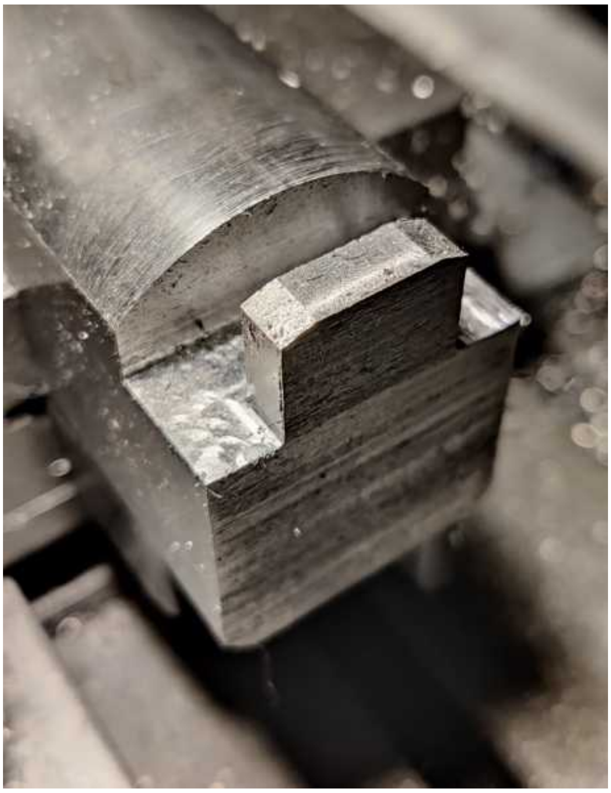
The slide starts from a 35mm round stock of 4140QT parted to length. Round stock is used, because it is the most widely available and economical form of 4140 steels, and due to shape of the part, material removal remains in reasonable scale and only few mm must be skimmed of each side; the largest portion comes from the bottom, behind the recoil spring lip, but this would be a factor with square stock, as well. It is quite possible to order parts that are pre-cut to the size with surface finish allowance, if desired, however plate and square stock may not be as well available pre-hardened, so in this case a heat treatment setup must be available.

# 3. Slide



The round stock is mounted on a vise, and the ends of the stock are trued by end milling the blank to final length. The recoil spring lip is slotted and milled out to separate it from the face milling process.

This surface is used as a reference when the part is re-mounted to form a 90DEG angle, with which the second side is milled to spec, and this is repeated, following specs, until a blank is formed.



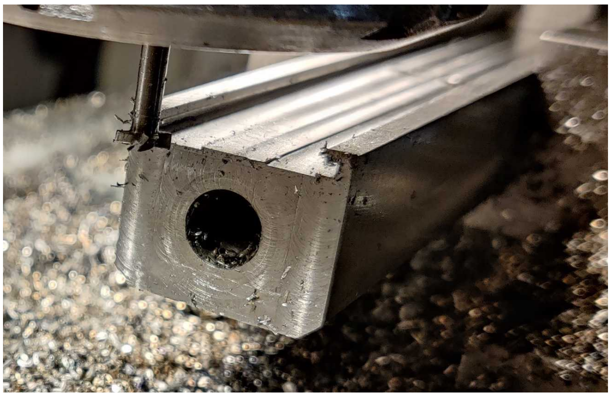
After all the sides have been milled, the recoil spring lip is milled to spec as final phase. Before de-mounting, the blank ends are trued with an end mill square to the sides.

After this, the slide top edges are relieved either by chamfering them using chamfer mill, 45DEG chamfering jig or rounded using an R5mm radius cutter, and the slide is turned to mill the remaining sides. The corners will remain edged as manual machining can not round them without a rotary jig tool, however, a separate filing and sanding jig is provided to be used when finishing and deburring the slide, so this phase is left as is.

# 3. Slide

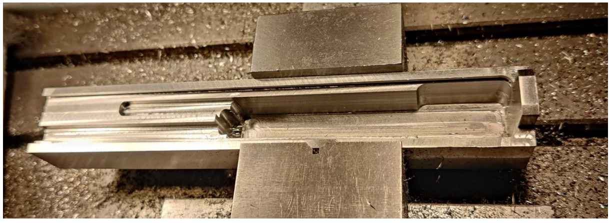
After this, the slide is mounted back up to the vise, and dialed in for firing pin channel drilling. Truing the slide is vital to ensure straighness of the channel. The channel is initially drilled to full depth using 4.5mm drill. It can be step drilled by first using smaller drill and enlarging the hole to at least 30mm depth using 4mm carbide end mill, and then finishing the hole to full depth using 4mm drill bit, and enlarging the hole to final 5mm diameter using larger drills and finally a 5.1mm reamer. After drilling the smallest diameter hole, the stepped holes are drilled and reamed using larger drills and reamers to specified depth.

After the firing pin channel is finished, the back is slotted using slot mill. Note that the machining order in this picture differs from this process, and the order is not critical.



In this order, the slide is mounted bottom side up to vise for interior milling. The slide is milled to feed lip depth, and the rails are milled using a slot mill.

The slide is mounted top up, dialed from front, and all the corner holes for ejection port are drilled and milled to spec. The interior of the slide is milled to feed lip depth.

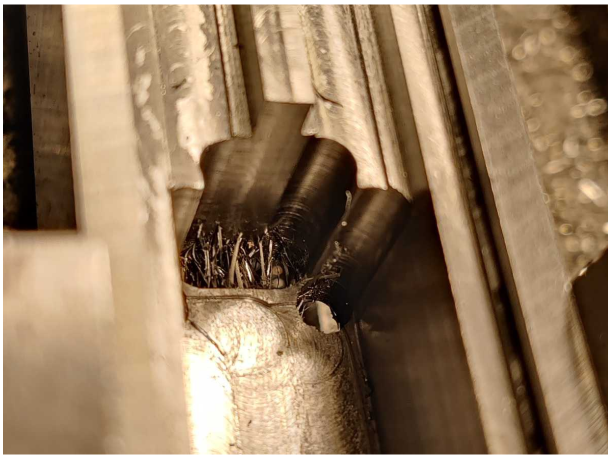


After determining the breech, the full interior pocket is milled.

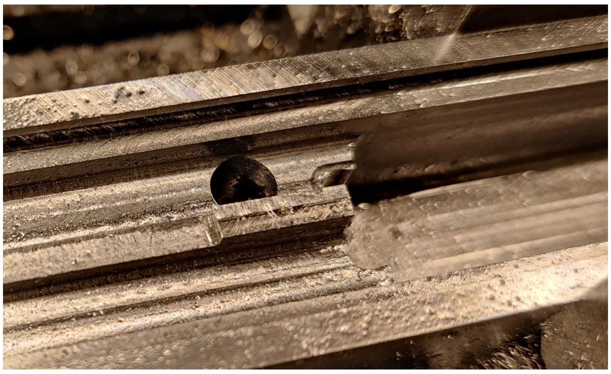
The front pocket is relieved, and the front sight pocket is plunge milled.

The breech face remains unfinished.

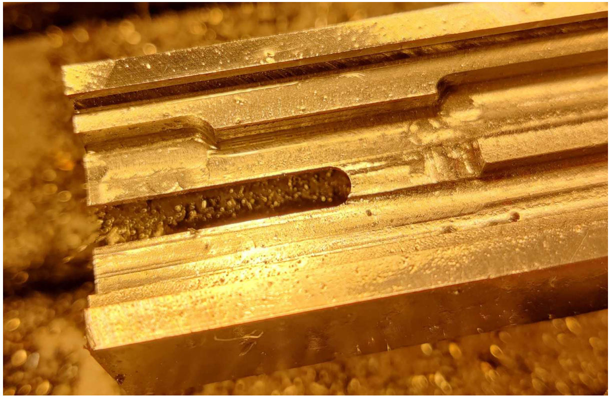
# 3. Slide



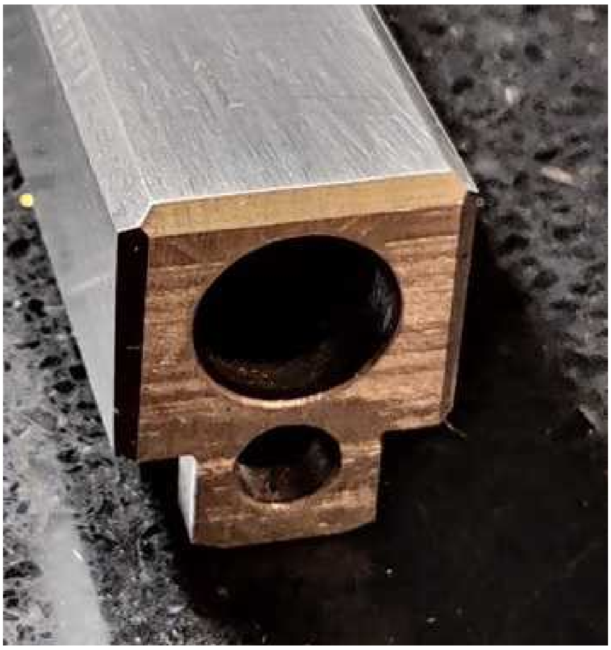
After this, the firing pin safety hole is drilled and plunge milled.



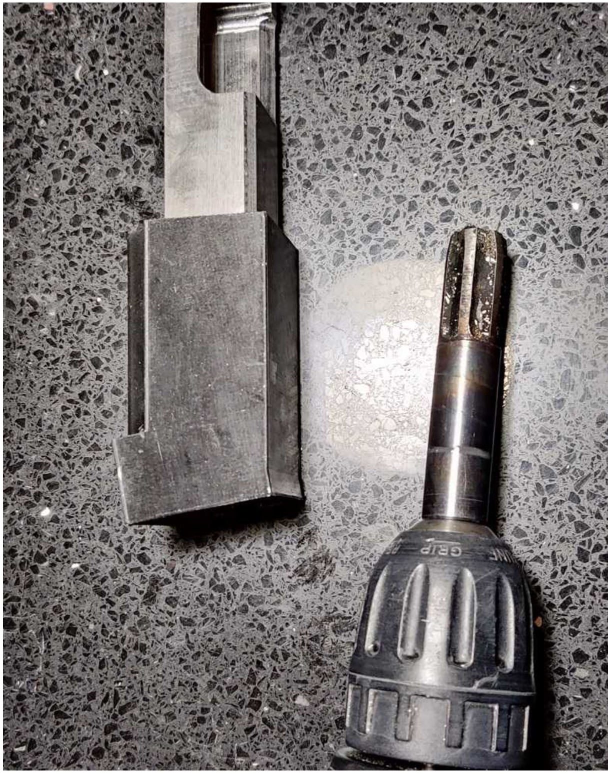
After this, the rear section is milled out, taking in consideration the disconnector edge and feed lip section. All the flats are milled out to final spec, and any angles are left to be finished later. The striker slot is milled using 4mm end mill.



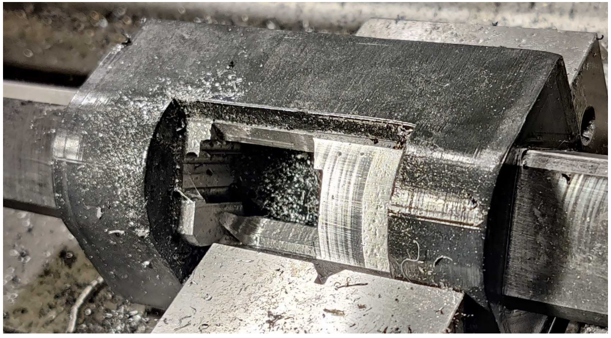
The slide catch slot is milled using the same end mill. The final angles are milled later with angle vise. Note the disconnector lip is still missing the angled front slope.



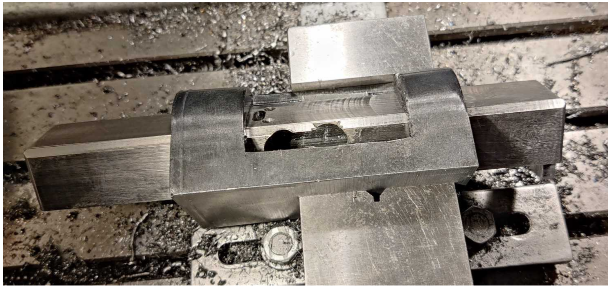
The slide is mounted front up, and the recoil spring hole is drilled and reamed. After this, the barrel hole is drilled in steps, and enlarged to 14.5mm final size. After this, the barrel hole angle jig is pressed over the slide, and using the barrel hole tilt reamer, a 10 degree tilt is reamed.



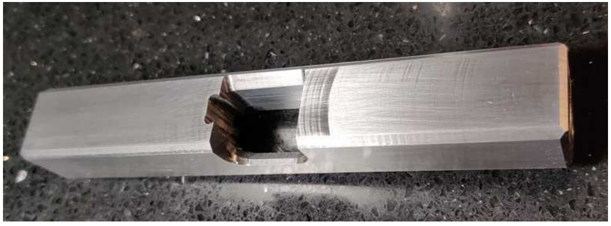
The slide is mounted right side up, and by using step drilling and finally 12mm HSS end mill, the side of the ejection port is finished to spec. After this, the slide is pressed in the ejection port milling jig, and the ejection port is finished using 4mm end mill to create the slope to the left side of the port by milling from the left side angle in order to create a fillet to both ends of the ejection port to eliminate stress raiser corners. After this, the slide is turned to other angle with the jig, and 12mm HSS end mill is used to cut the relief angle to the right side of the ejection port. Ejection port specs are checked, and milled if necessary.



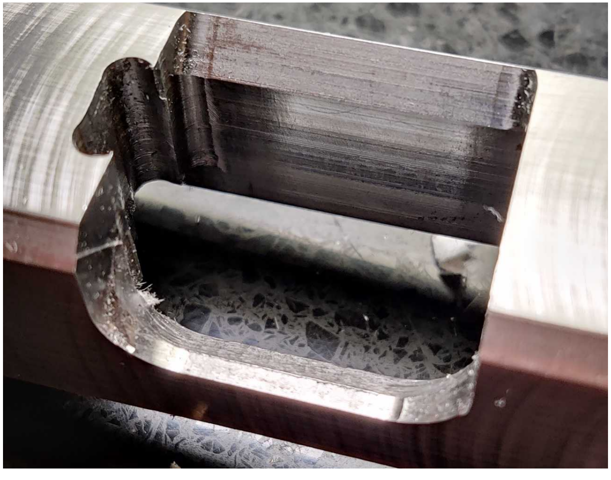
The ejection port is milled from both angles. The round corners at the side are formed by positioning and step plunge milling, and then removing the residual material.

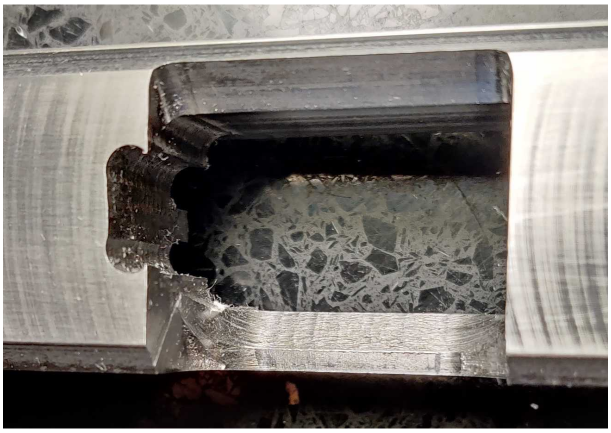


The left side of the port is milled using either bull nose end mills, or from left 45DEG angle using the radius of an ordinary end mill to form round corners.

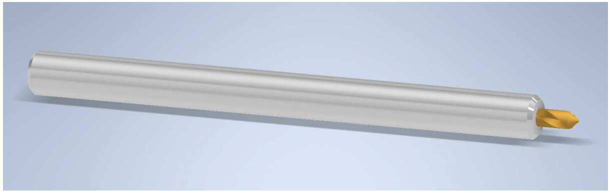


The inner relief is milled using this same method with proper radii end mills.

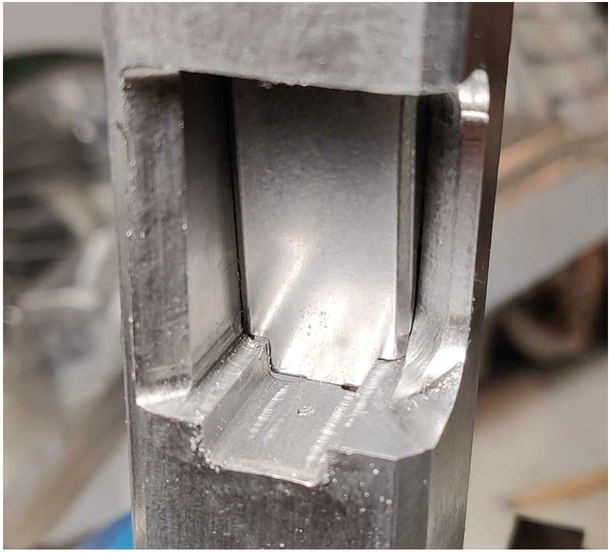




Care must be taken, because the size of the ejection port is of critical dimension that determines the locking position of the barrel and must be within 0.1mm or less to avoid excess headspace. Recommended approach is to leave allowance when milling, and doing the finishing pass on the front face after everything else is milled.

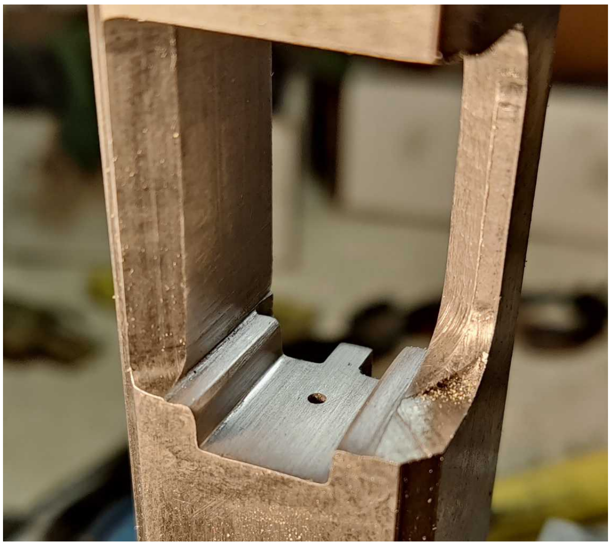


After the ejection port is finished, the firing pin hole is drilled through using firing pin hole drill tool. The tool is made from 5mm round stock, with proper sized drill bit mounted with minimum amount of overhang to allow full penetration of the remaining wall between breech and firing pin channel.

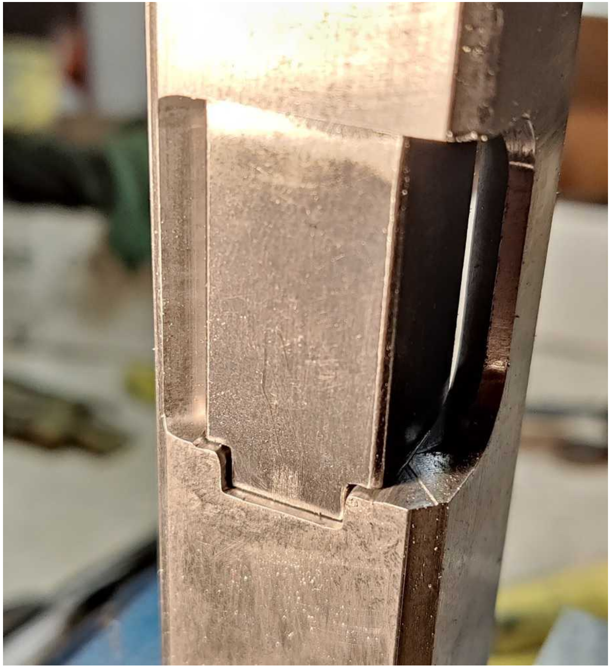


The breech forming can begin. A custom broach is provided that is used to finish the breech, so allowance is left, but the initial work is done by hand filing. Care must be taken to keep the face at 90DEG angle.

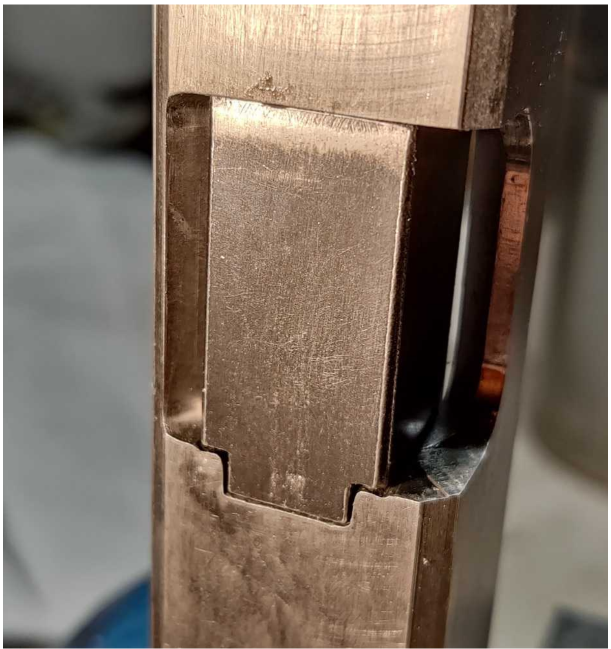
# 3. Slide



The breech is shaped by first roughing using larger file, and then procceeding to using finer files.

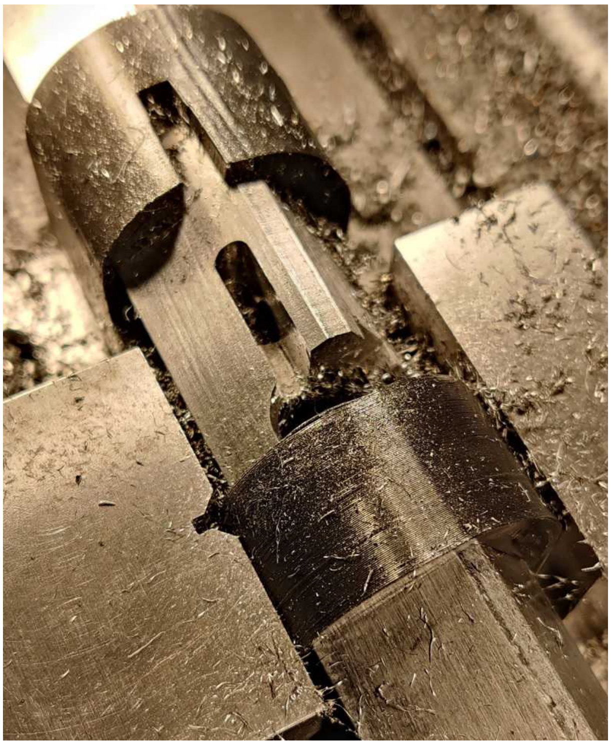


After filing, the barrel fitting is checked, and when the barrel is almost in battery, care is being taken to assure parallelism of all surfaces, and checking out which point of the breech is touching the barrel, and evening out the face until a full fit is achieved.



Finally the barrel will fit in place. It should be slightly snug at first, to leave working allowance, and after this, only sandpaper of 240 or higher grit is used to work the surfaces, and parallelism is checked.

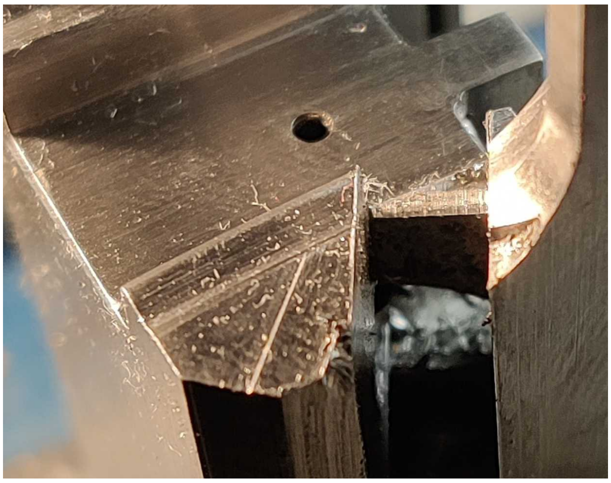
After this, the breech broach is used to broach off the breech edges and uniform the corners.



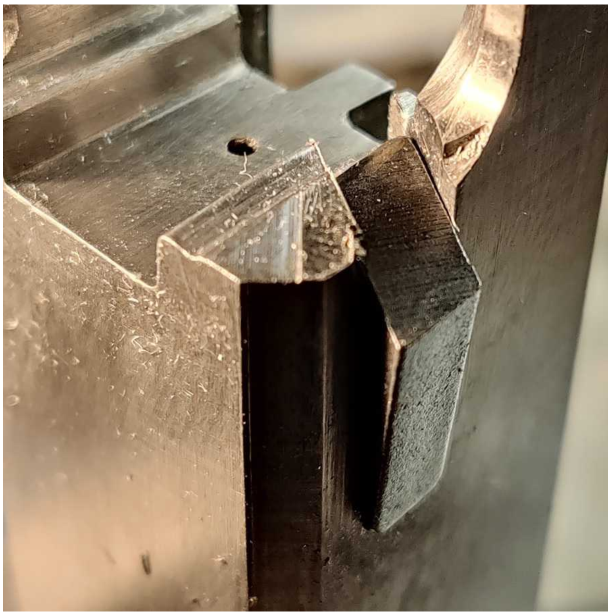
The barrel is placed in extractor milling jig, and it is dialed in, and the extractor slot is milled to spec and the rear recess for extractor pivot pin is drilled. Extractor can be fitted in slot to check free movement. After the slot has been milled, a 4mm extractor slot broach is used to remove the remaining wall between the slot and the breech, and broaching is done until the extractor slot is flush with the breech.

# 3. Slide

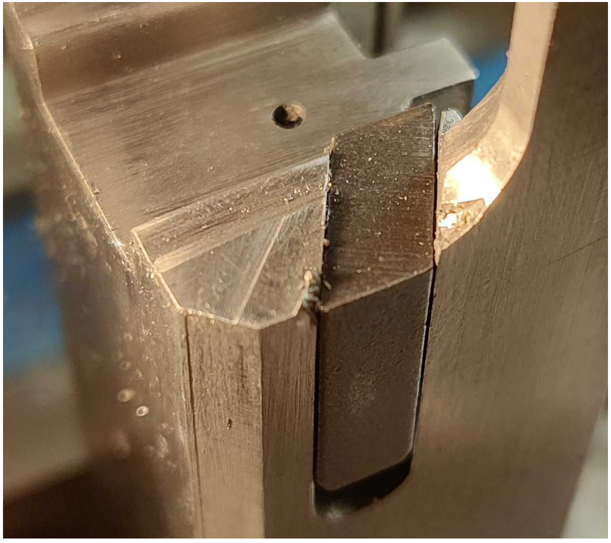
In case the extractor does not fit in the slot, it can be deburred using needle files. This is common occurrence after broaching, as the broach flexes slightly, and it is commonplace to need for some deburring.



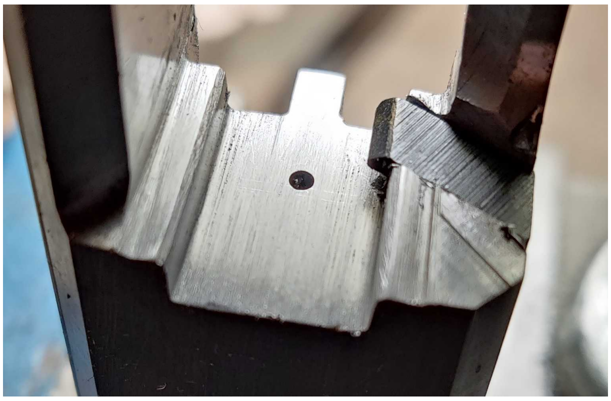
The wall broached can be seen at the top of the extractor slot.



Extractor not fitting, more deburring needed.

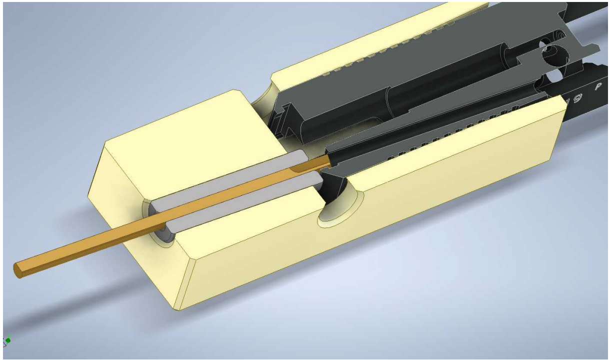


Extractor fitting properly.



Extractor should be flush with the slide wall, and protrude over the breech.

After this, the slide is fitted in the extractor plunger hole drilling jig. The slide is mounted to a rigid vise. A 4mm center drill is used to drill a starting hole to the slide so it starts straight, and a normal 4mm HSS-Co drill is used to drill as deep as possible, and when there is no more allowance, extra long drill bit is swapped in order to prolong the more expensive drill bit life.

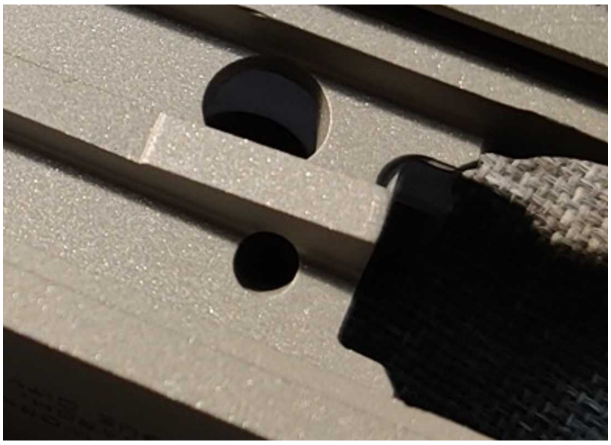


The plunger hole drilling jig consists of 3D printed sleeve, that is pressed over the slide, and hardened steel insert that is pressed in the 3D printed sleeve, which aligns the drill to proper angle and position. It is highly recommended to use 3.5mm custom D-bit drill to create a flat face to the slide, before engaging using ordinary twist drill. This will ensure the drill starts parallel to the drilling direction. Even slight deviation will cause the part to be likely scrapped, so extra care should be given to this step.

Note: it is possible to do this step immediately after facing the slide to initial dimensions to ensure the hole is aligned properly and prevent the risk of scrapping a part into which several machine hours has already been invested.

In case no long enough drills are at hand, the jig can be removed after minimum of 30mm has been drilled, so the hole will begin to lead the drill.

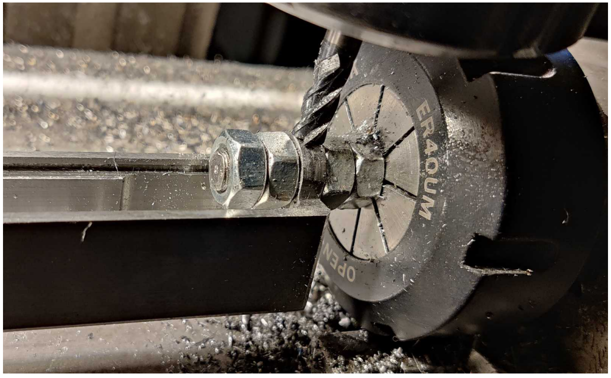
Use ep oil and low to medium rpm with keeping constant drill pressure, and retract drill often to remove chips and re-apply EP oil. Alloy steels can work harden and dull drill bits if high rpm and low tool pressure is used, after which usually a carbide tool is needed to continue drilling. With low RPM the 4140 is very machinable and has provided no issues so far when making this manual. The drill bit should punch through the extractor slot mid back. The jig is removed, and the hole is reamed to spec.



Vent hole purpose is to expel high pressure gas in case a primer rupture occurs. In case there were no vent hole, all the pressure would be exerted to the striker, which can damage it and it's components and jam the gun.

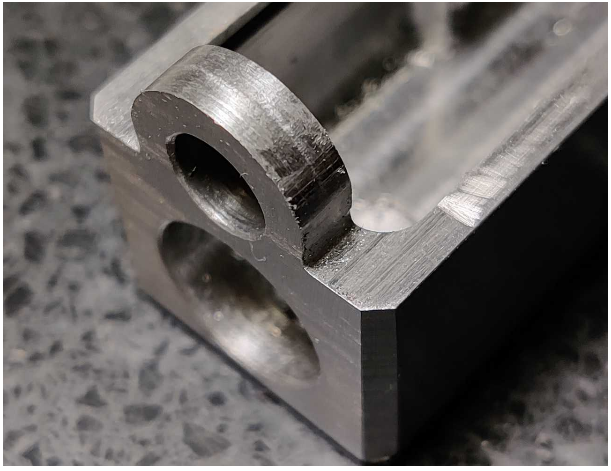
The slide is mounted to vent hole drill jig, and the vent hole is drilled through to firing pin channel. The function of this hole is to vent out any air or water from firing pin channel and eject gases in case of primer rupture, which could cause the striker to blow back, damaging the gun.

The slide is mounted top up, and front and rear sight slots are milled to spec. The rear slot is finished by running a dovetail cutter through it.



The slide is mounted over an 8mm threaded rod, turned down to 7.5mm, and threads will remain allowing sliding the slide over while still retaining nuts. Nuts are tightened according to picture and the recoil spring lip radius is milled. The part is carefully rotated by hand, and the milling cutter is fed lower, until a full radius is formed and the part is measured to be in spec.

Note: the milling cutter must remain on top of the part at all times. This way the cutting forces will be only axial. In case side milling was used, the cutter will grab the part violently, damaging the part and usually breaking the cutter. Manual radiing has great harm potential if the part grabs, and this method can only be used for very small parts radius forming.



The finished radius looks very smooth even though it is hand guided.

The slide is mounted sideways, and the grip grooves are milled using 3mm end mill to 0.4mm depth by dialing the position from the slide's end. Make sure the slide is parallel and flat to ensure uniform cut depth.

The slide is finished by milling all the angled surfaces by using angle blocks or an angle vise. Sides with angle blocks are:

- Slide catch slot front taper
- Slide catch up-down taper
- Feed lip back taper

Angle vise sides are:

- Disconnector taper
- Slide catch sideways taper

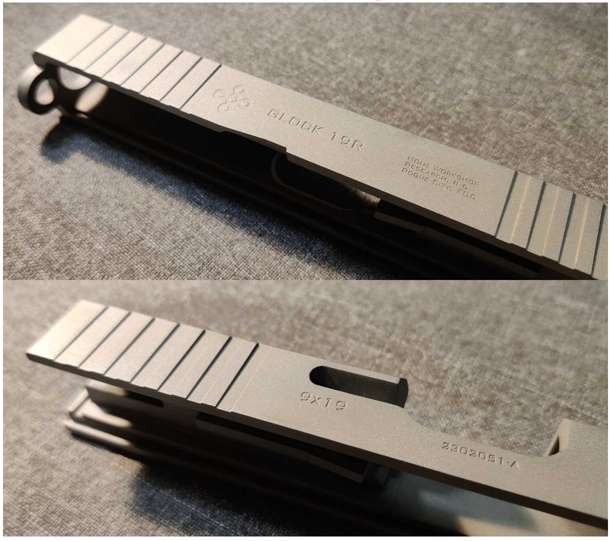
When the slide machining operation is completed, the slide is deburred by hand by using needle files and sandpaper to remove all burrs and breaking all sharp edges, and the part is cleaned to remove any chips, dust or cutting oil.

All the small parts are assembled and fitted to the slide, and fine tuning is done if necessary in order for all the parts to fit smoothly. Only after this step has been done, the slide can be finished.

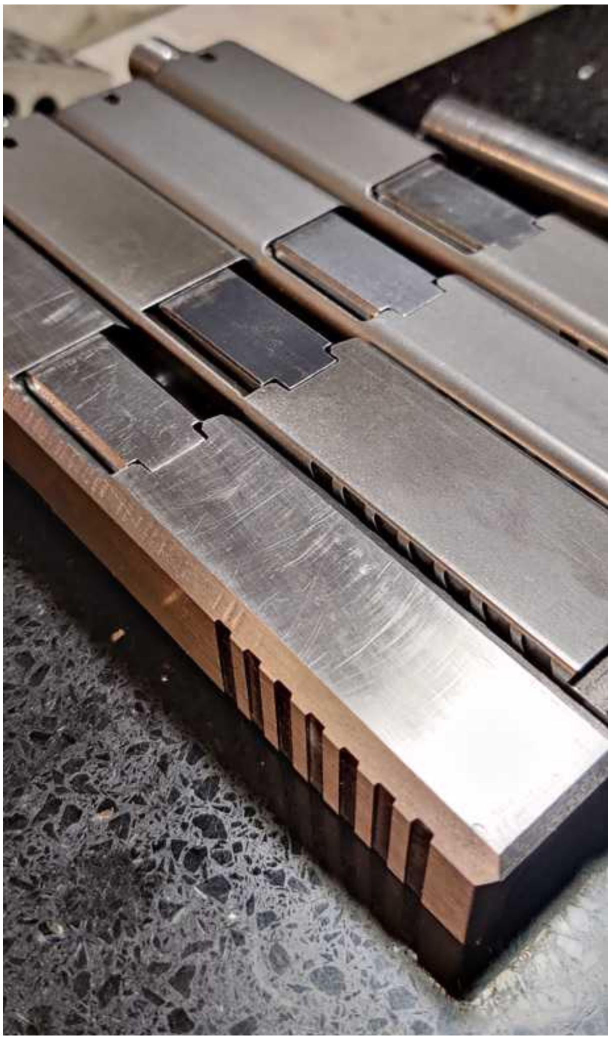
The slide sides are smoothed by surface sanding. A sandpaper of increasing grit is placed on smooth plate, preferably polished flat stone surface, ideally a surface plate, and the slide is slided over the sandpaper through linear one-directional movement only, and this is done until all the machining burrs are diminished. A finer grit is used to smooth out the sides, until a desired level of smoothness is acquired. A 400 grit has been found to be satisfactory.

Genesis slide and barrel, after surface sanding.

After deburring, the slide is marked if desired using methods described in Finishing chapter.

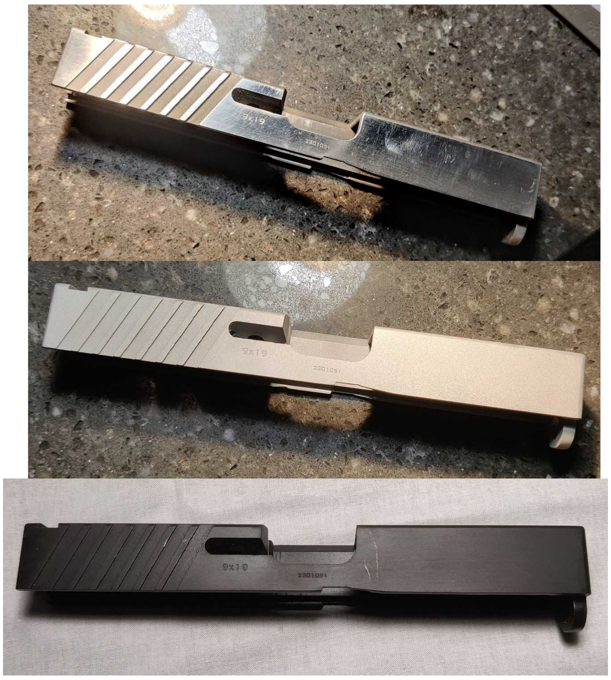


# 3. Slide



If available, vibratory tumbler with porcelain media is used to wet tumble the slide to deburr it and create an uniform, smooth but dull finish. Even better, ideal option is sandblasting.

Before and after sandblasting.

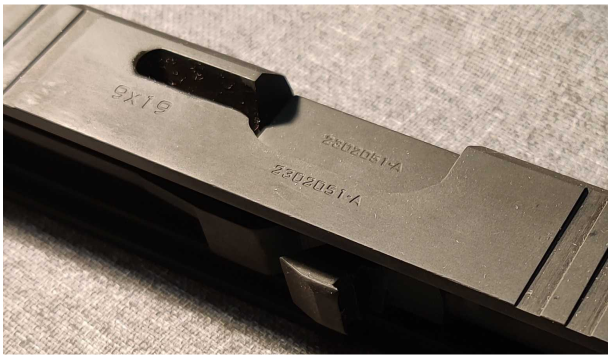


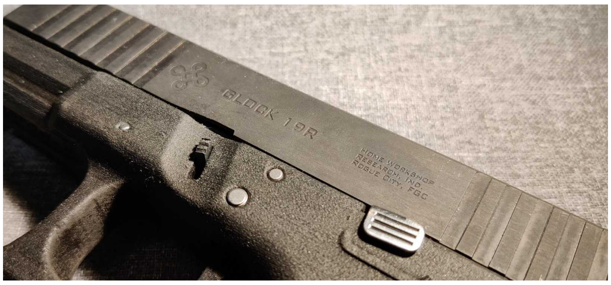
Pictures of genesis slide, from process finish to sandblasted to hot blued. Note the scratching due to the slide being unhardened mild steel. This slide was produced only to develop the process and was not intended to be used.

The slide is either hot blued or parkerized as desired, and oiled properly according to instructions.

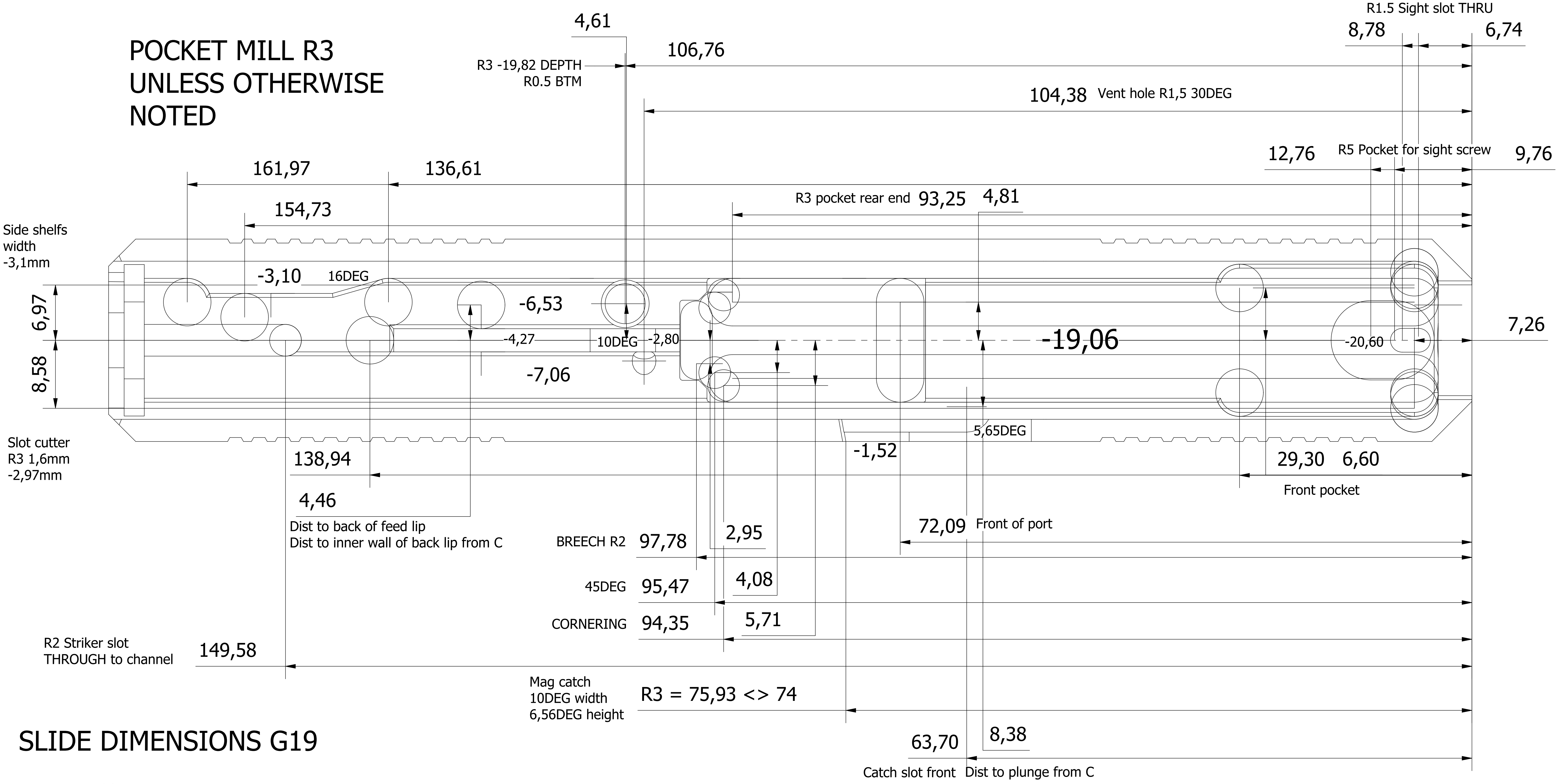
After assembling and testing functions, the slide is now ready for use.

# 3. Slide


9x19
2302051-A
2302051-A


GLOCK 19R
HOME WORKSHOP
RESEARCH, INC.
ROGUE CITY, FGC

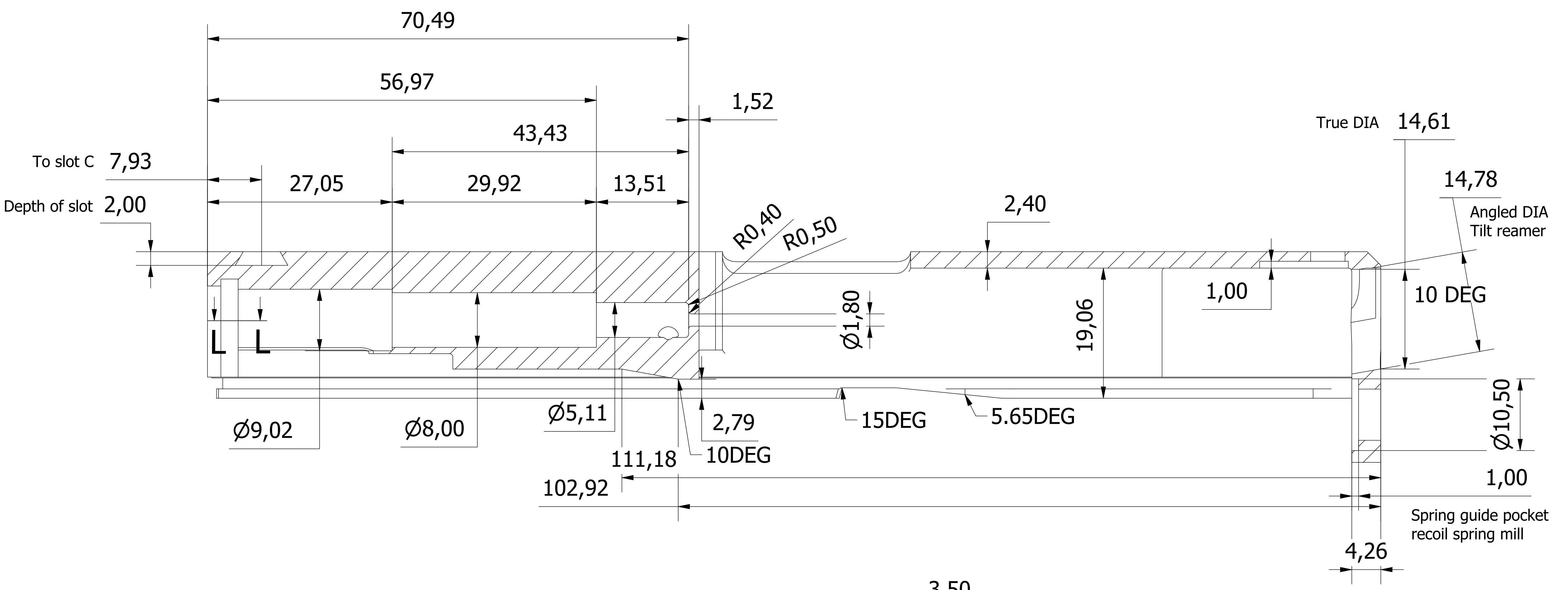
POCKET MILL R3
UNLESS OTHERWISE
NOTED

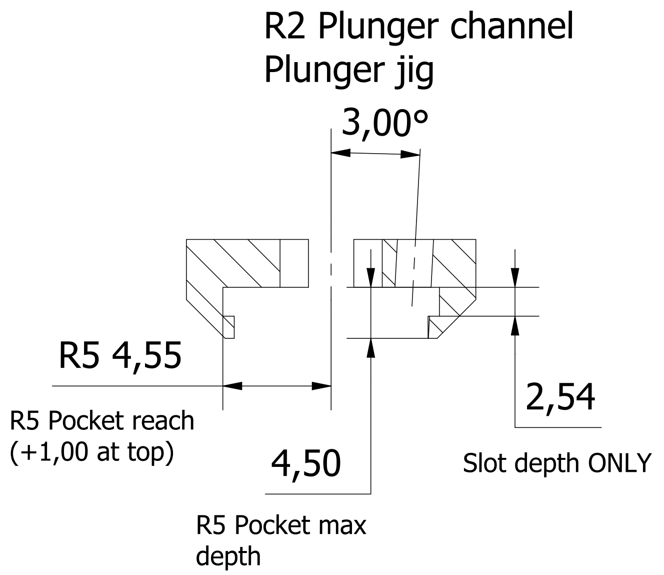


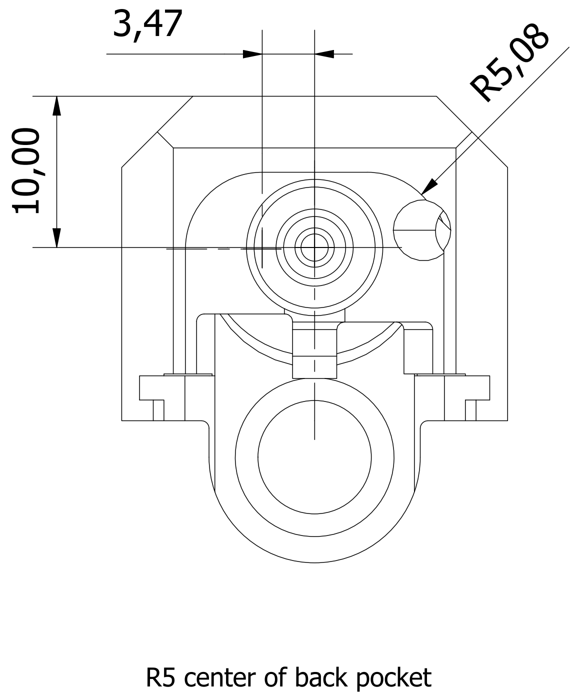
# SLIDE DIMENSIONS G19

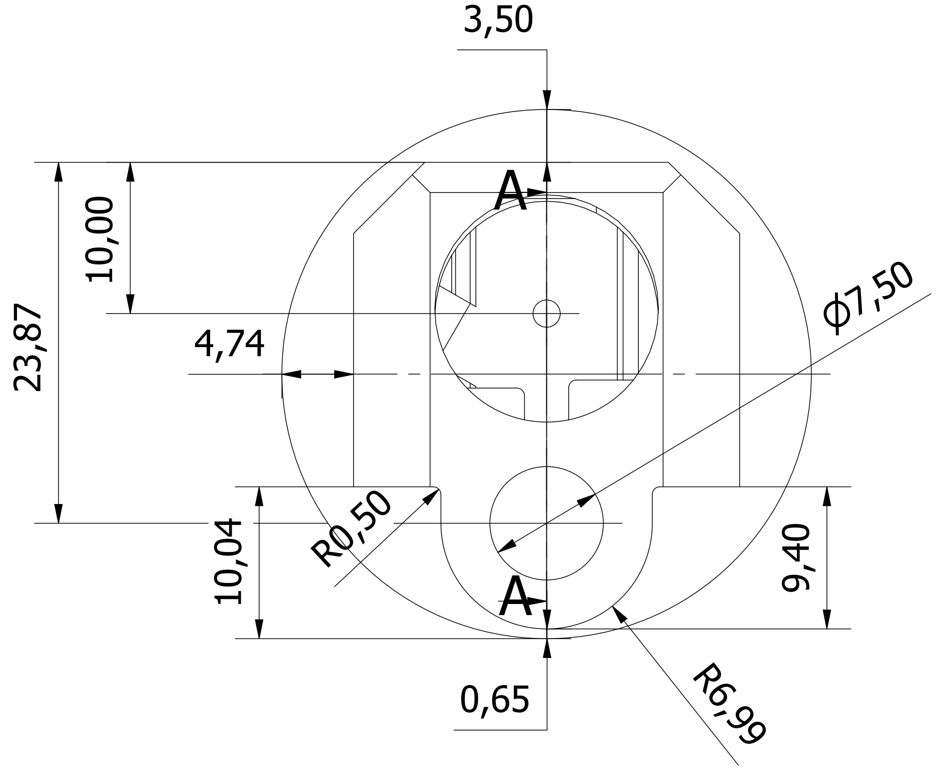
**OAL** - 171,88
**WIDTH** - 25,53
**BODY HEIGHT** - 21,46
**MAX HEIGHT** - 30,86

Designed by
HWR
Checked by
Approved by
Date
Date
Slide G19R
Edition
Sheet
1 / 4









# ROUND STOCK
# MILL PROGRAM G19

Material removal rate from each parallel side

STOCK: Dia 35mm

1. **TOP** - 3,50
2. **SIDES** - 4,74
3. **BOTTOM BODY** - 10,04
4. **BOTTOM LIP ONLY** - 0,65

| | | | | |
|---|---|---|---|---|
| Designed by<br>HWR | Checked by | Approved by | Date | Date |
| | | Slide G19R | Edition | Sheet<br>2 / 4 |

# Slide chamfering dimensions

**Dimensions are given at 45DEG angle parallel to body, and parallel to chamfer face**

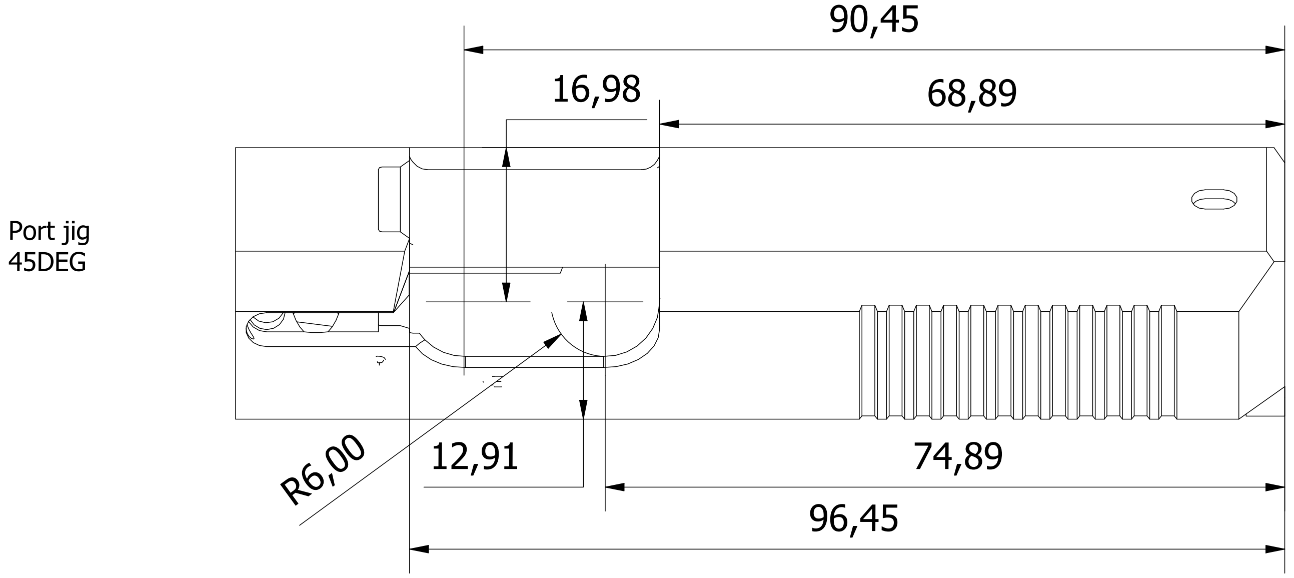
**FRONT TOP**
2mm angle
2,83mm FACE

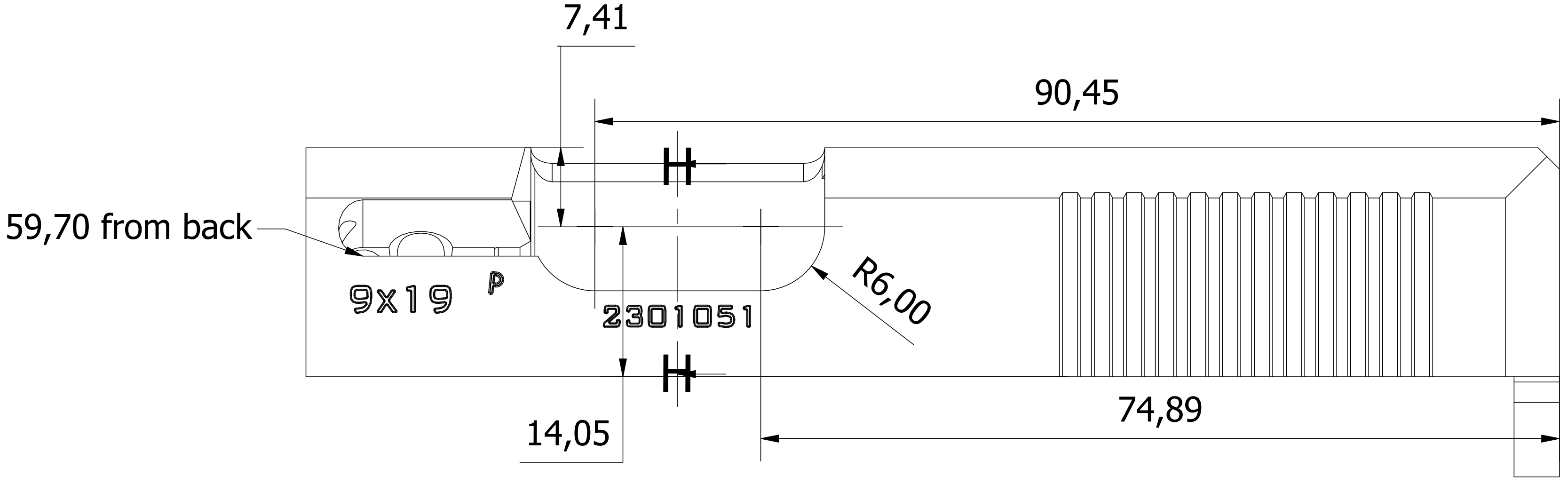
**FRONT SIDES**
5,06 angle
7,16 FACE

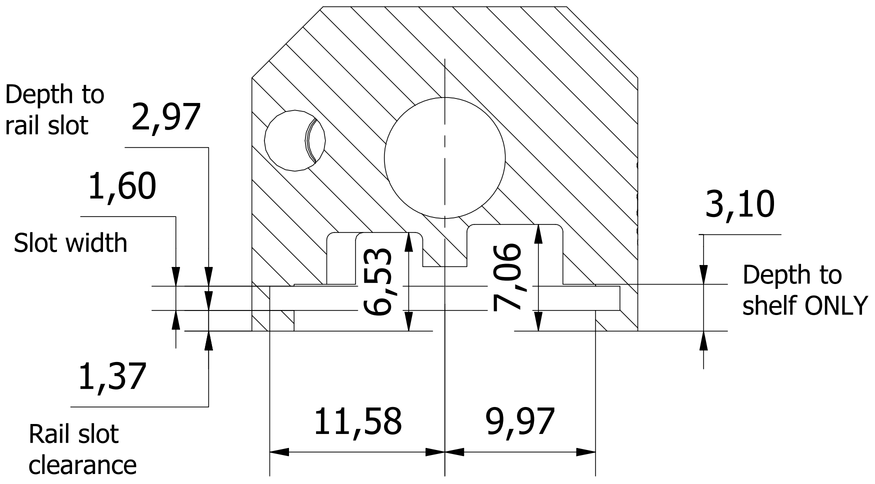
**BACK TOP**
3,41 angle
4,83 FACE

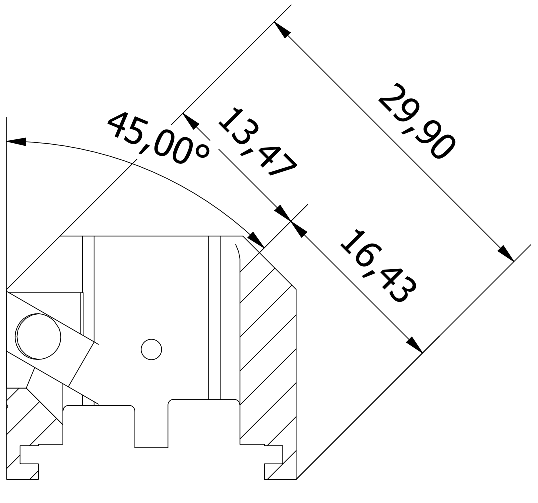
**SIDES**
4,71 angle
6,66 FACE

**BACK SIDES**
3,41 angle
4,83 FACE

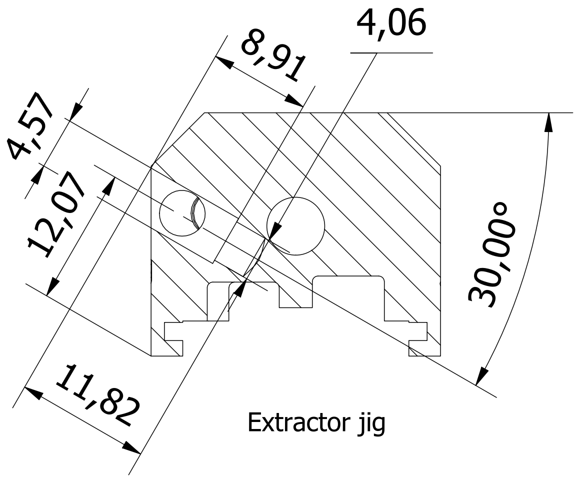








Port jig



Extractor jig

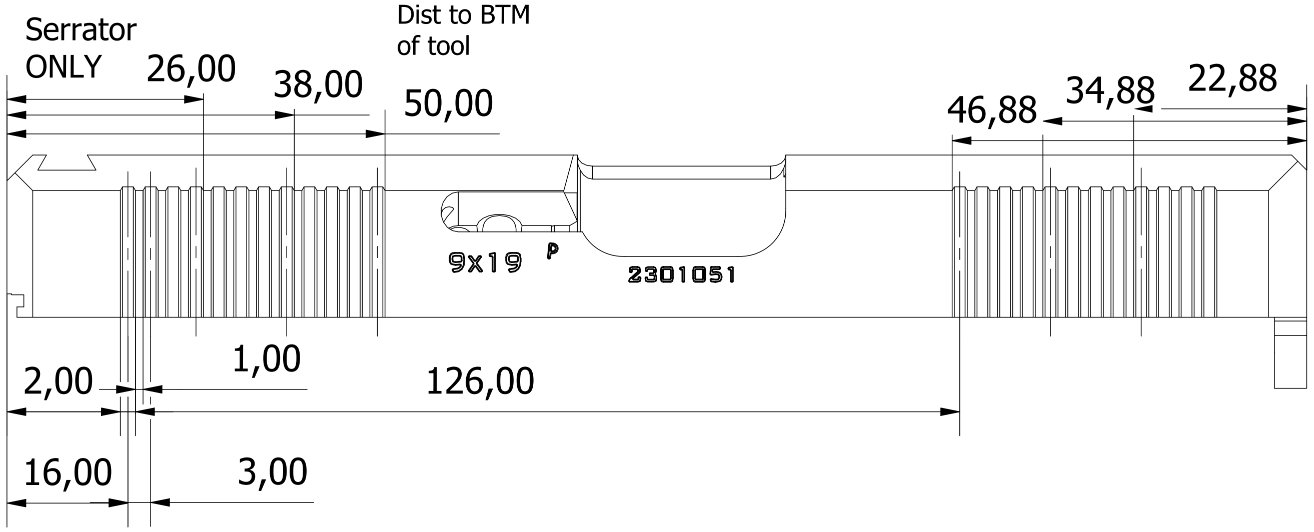
| Designed by | Checked by | Approved by | Date | Date |
|---|---|---|---|---|
| HWR | | | | |

| | Edition | Sheet |
|---|---|---|
| Slide G19R | | 3 / 4 |

# Machining protocol

**Material: 35mm round stock, 4140, 40-45HRC**

1. True ends to spec. Face mill external dimensions.
2. Mill recoil spring lip around to isolate.
3. Drill, plunge mill breech and ejection port guide holes.
4. Drill firing pin safety hole.
5. Mill full interior to spec, punch ejection port to rough size, full width to fit broach.
6. Slot mill rails.
7. Mill slide catch slot.
8. Broach breech.
9. Drill, plunge mill ejection port open from slide.
10. Mill at 45DEG using jig to final spec.
11. Mill extractor slot and hole with jig, plunge remaining wall to max and broach remaining radius with 4mm broach.
12. Chamfer slide from top, either with angle jig and endmill or using R5 radius cutter. In latter, mill corners using chamfering jig.
13. In vertical milling mount, predrill with 3.5mm to 20mm depth, true with 4mm carbide endmill. Drill with 4mm drill to full depth. Enlarge to 5mm.
14. Ream hole with channel D-bit to full depth.
15. Mill slide back slot with 10mm endmill and 10x2mm slot cutter.
16. Flip slide, drill barrel hole and spring guide hole, ream to spec.
17. Radius mill spring lip.
18. Ream barrel hole to angle using jig and reamer.
19. Using plunger jig, drill plunger channel.
20. Drill front sight mount hole, mill back sight slot.
21. Mill grip grooves.
22. Plunge mill fpin vent hole using jig.
23. Using angle vise, shape: ejection port angle, feed lip angle, slide catch slot, disconnector slope
24. Drill firing pin hole with pin reamer.
25. Hone striker channel and safety plunger hole.
26. Deburr part, check all measurements are in tolerance or fit to other parts freely, fine tune if necessary.
27. Tumble finish, perform surface finishing.



Rear:

16, 19, 22,
25, 28, 31,
34, 37, 40,
43, 46, 49

Grips from rear:

Width: 2mm
Spacing: 1mm
BtwC: 3mm
Depth: 0.4mm

Front:
126, 129, 132,
135, 138, 141,
144, 147, 150,
153, 156, 159

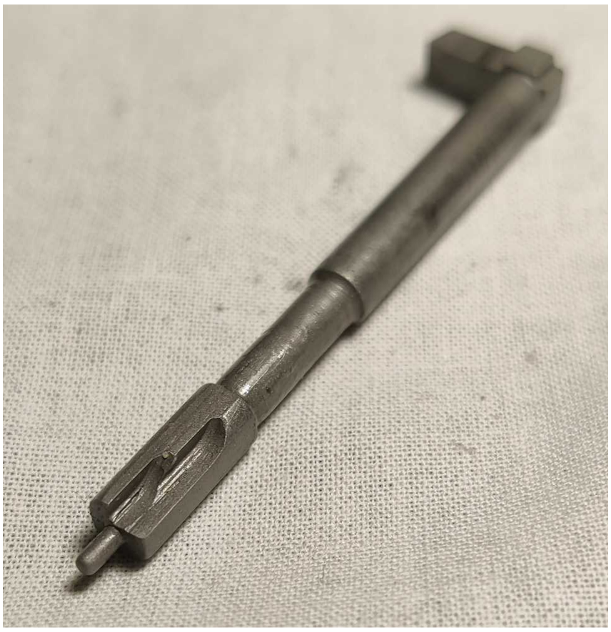
| Designed by | Checked by | Approved by | Date | Date |
|---|---|---|---|---|
| HWR | | | | |

Slide G19R

Edition

Sheet
4 / 4

# 4. Striker



A striker manufactured for the G19R.

Commercial strikers for Gen 3 Glocks are either made with MIM or machined from 17-4 stainless or alloy steel. Perhaps the most recognizable feature of it is the square firing pin head, that fits into a square firing pin hole. In Gen5, the firing pin shape has been changed closer to a more conventional design.

As this feature is relatively easy to machine to the striker itself, but a very difficult task to replicate to the slide, a decision was made not to even attempt it, but instead use a simple, round nose firing pin. The firing pin head size is based on multiple commercial designs and sits in between the typical range of 1.5-2mm diameter pins. The firing pin hole is drilled slightly larger to accommodate possible slight misalignment of striker channel and reduce proneness of jamming due to dirt or other factors.

This creates an interchangeability issue with commercial strikers, but given the fact that commercial strikers for Glocks tend to be quite expensive, making the striker in shop becomes warranted, and it also removes dependence from one more commerical part, and brings closer the ability to fabricate every part in shop. All commercial striker accessory parts, including firing pin safety, are compatible with this design. Gen5 strikers could be made compatible in case the firing pin hole were to be drilled larger, as the pin head is slightly drop shaped, however this may cause issues with primer brass flow due to unsupported firing pin channel.

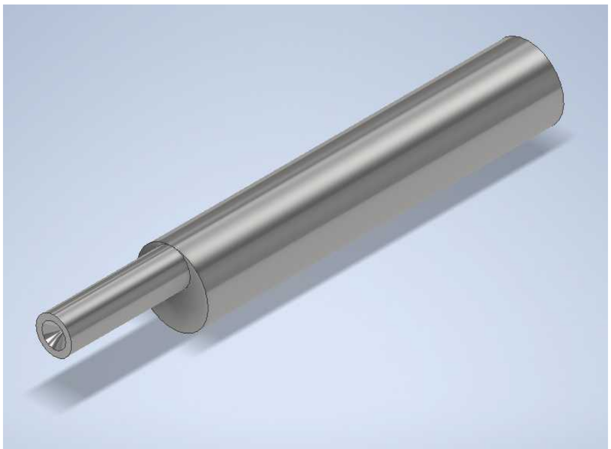
The striker can be turned from solid stock, but it is desirable to use either off center turning with independent jaw chuck or turning an off center support shaft between centers, as this allows significantly smaller stock to be used and reduces the amount of material removed a lot.

The material for the striker can be selected from few different options. Most straightforward and accessible method is to use 10.9 or grade 8 bolts or threaded rod. They retain similar properties to typical 4140QT, and are tough and sufficiently hard to not wear down over the expected life of this type of firearm, with minimum round count of several thousand rounds. Unfortunately bolts can not be effectively used as a replacement for off center mounting, as there is no way to mount it and being able to make all the details over one mount, however the shaft can be used, after cutting the head off. If available, 4140QT round stock can be used instead. O1 tool steel is also very suitable for the purpose, but requires heat treatment after turning.

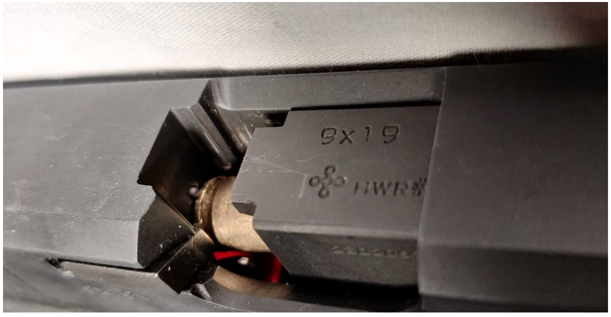
The process begins by marking and drilling 12mm thick shaft from 3mm off center to both ends, using collet block or V-block as indexing tool. Heads are drilled with center drill, and the part is mounted between centers.

End of the shaft is turned to maximum possible full diameter, here 6mm, and dismounted. The part is now mounted to lathe using this off-centric mount shaft.

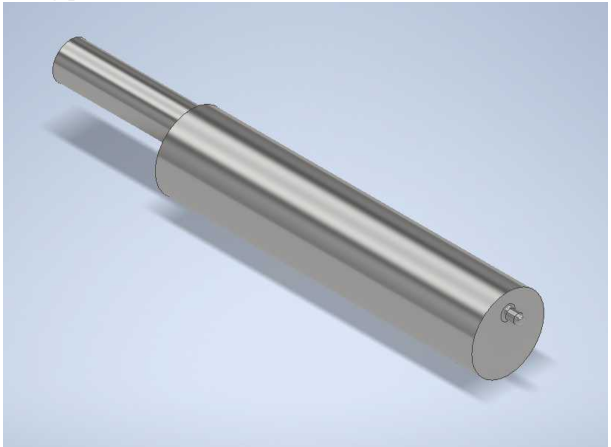
# 4. Striker



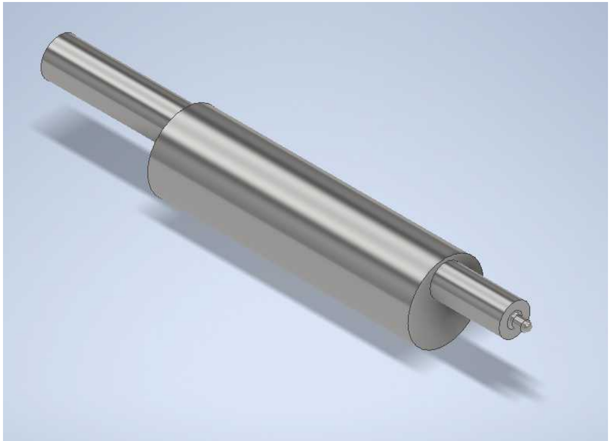
The part has to be step turned to retain as much rigidity as possible due to long unsupported overhang. Here, the shaft is faced to remove the mount hole, and the firing pin head is turned. It is noteworthy that the firing pin head must not exceed specified length, as it can cause failure to feed when the case head grabs the protruded firing pin head if it is too long; in spec firing pin head is sufficiently short so the case rim will trip over it and push it back in, in case it remains extended.



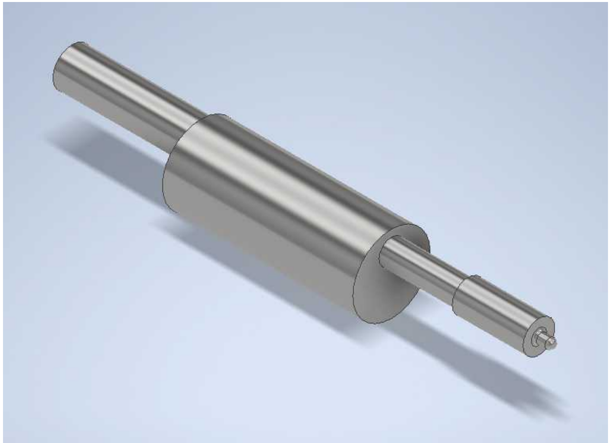
This phenomenon may occur when the gun is dry fired when empty, and a loaded magazine is inserted in and the gun is cocked. In the picture, a sample of too long firing pin head has caused a feed issue.

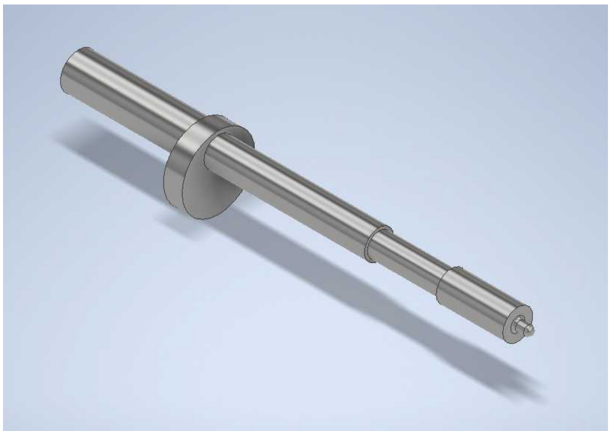


The work continues by turning the first step of the shaft to spec.



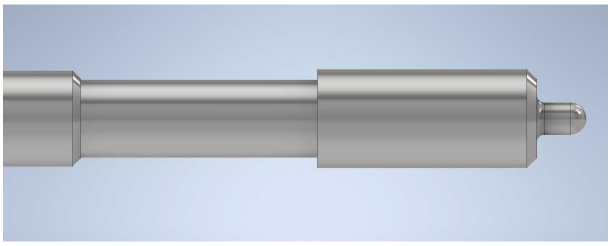
The step turning is procceeded until the full shaft has been turned. An allowance of 0.05mm or similar can be left for finish grinding.



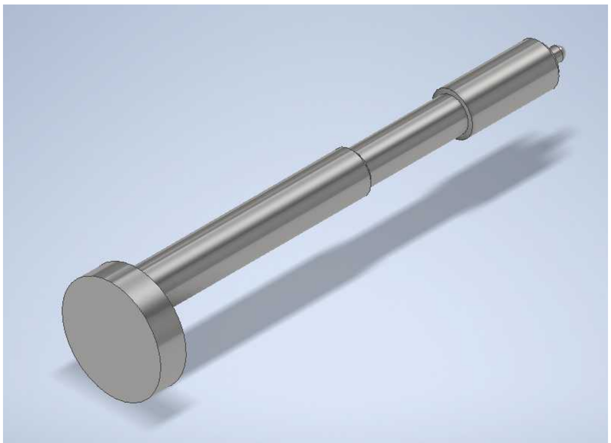


After turning, the shaft will look like this. The edges are chamfered, except for the shoulder behind the first step, from which only the burred edge can be broken, as this shoulder will face the striker spring cups.

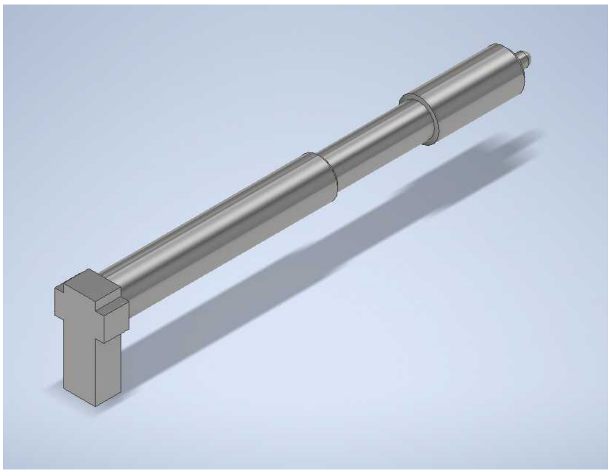
# 4. Striker



The mounting shaft is parted off, and the striker is turned to final OAL.

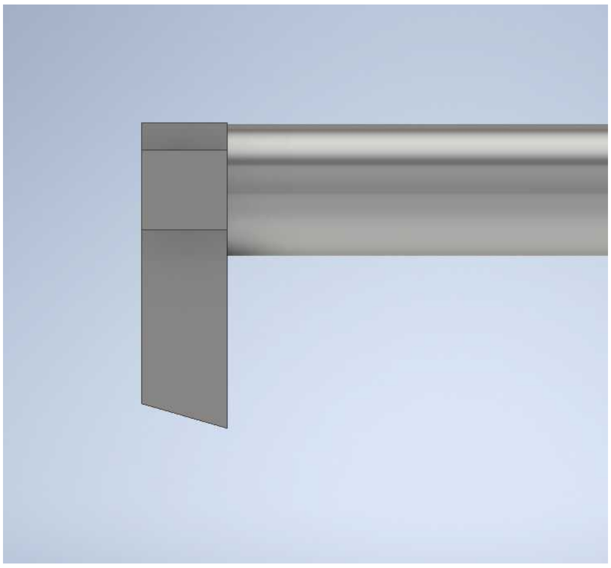


After this step, the part is mounted to milling machine using either collet block or a horizontal rotary table. The sear block is now milled to spec, forming a shape of a cross.

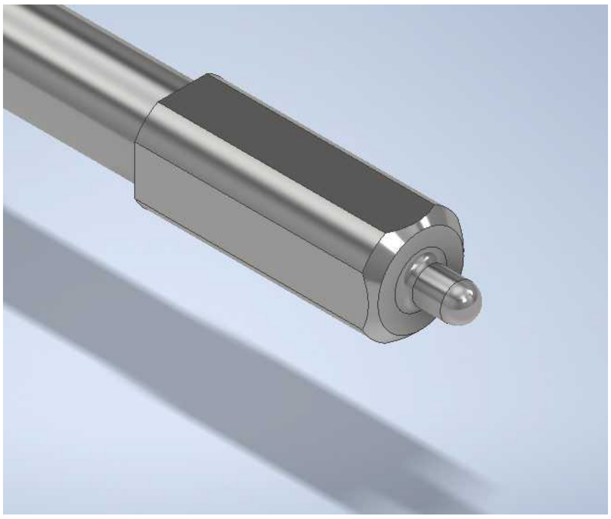


After this, the sear edge is relieved to specified angle.

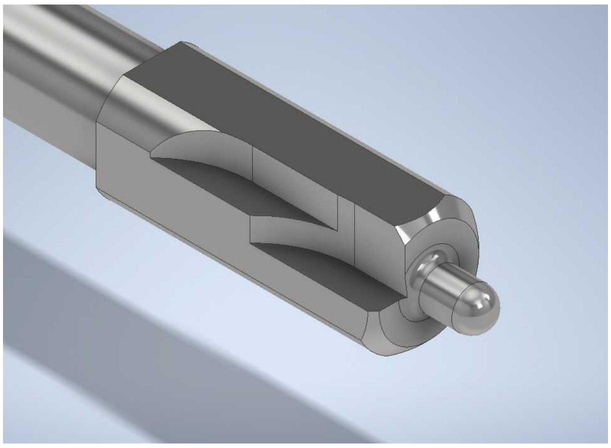
NOTE: this step can be optionally performed as the last step, if fixed rotary table is used, but using collet block, this step is easy to perform at once.



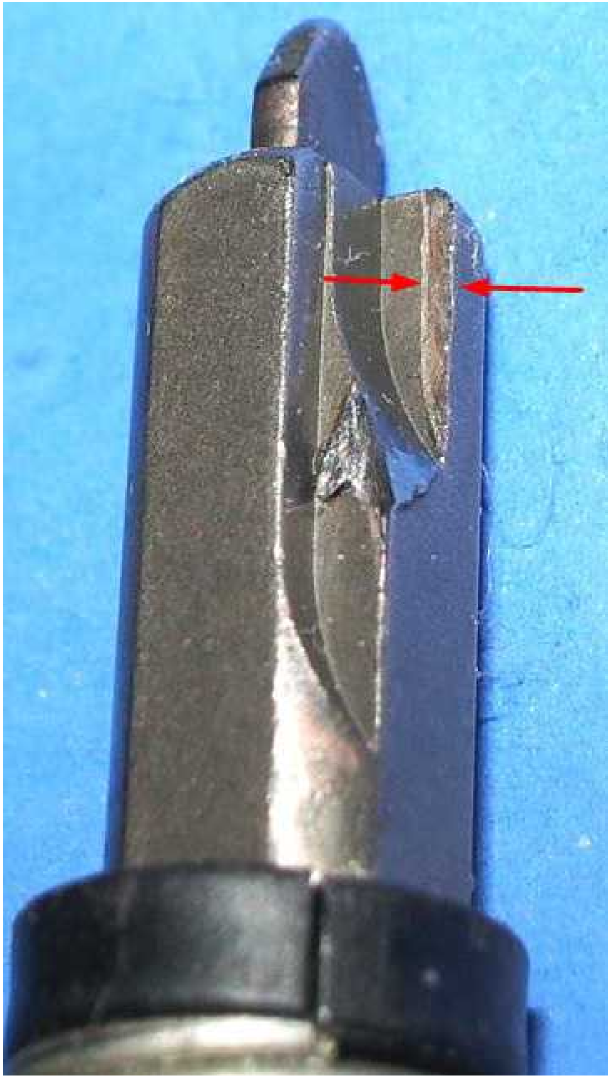
After this, the part is re-mounted and dialed in, and the front section is faced to create four flats.



After this, the striker safety slots are milled to spec.



The striker safety flats have been milled slightly lower in these drawings compared to the original model compared, because it was noted that during testing, a typical striker safety buffing issue was observed, and this may be caused by various factors, such as too low reach of trigger bar safety pin lever, or slightly misaligned striker channel. The relief does not affect the safety and functionality of the gun, but reduces the risk of misfires and light strikes.



The typical wear pattern presented here. This phenomenon occurs with commercial guns as well, and may be caused due to off spec parts, wear or misalignment of any kind, and while it may go unnoticed, it can increase the risk of light strikes and misfires, and if the reliability is to be maximized over some safety, milling the striker safety slots slightly deeper can be performed. The drawings included here are altered for this purpose. The decrease in safety is negligible, and it could possibly only manifest in case the gun is compared to full drop safety tests and could be marginally more prone to go off when dropped from sufficient height at very specific angle, however in practice this should not induce any decrease in safety and the safety will prevent striker reaching the primer at all times under normal conditions.

Note: the striker safety is not necessary for the function of the gun itself at all, and in case of simplicity it can be left off entirely, as can the striker safety hole itself. The gun will function without the striker safety, however as there is nothing preventing the striker from falling to the primer if the trigger bar trips, the gun may discharge when dropped or rough handled.

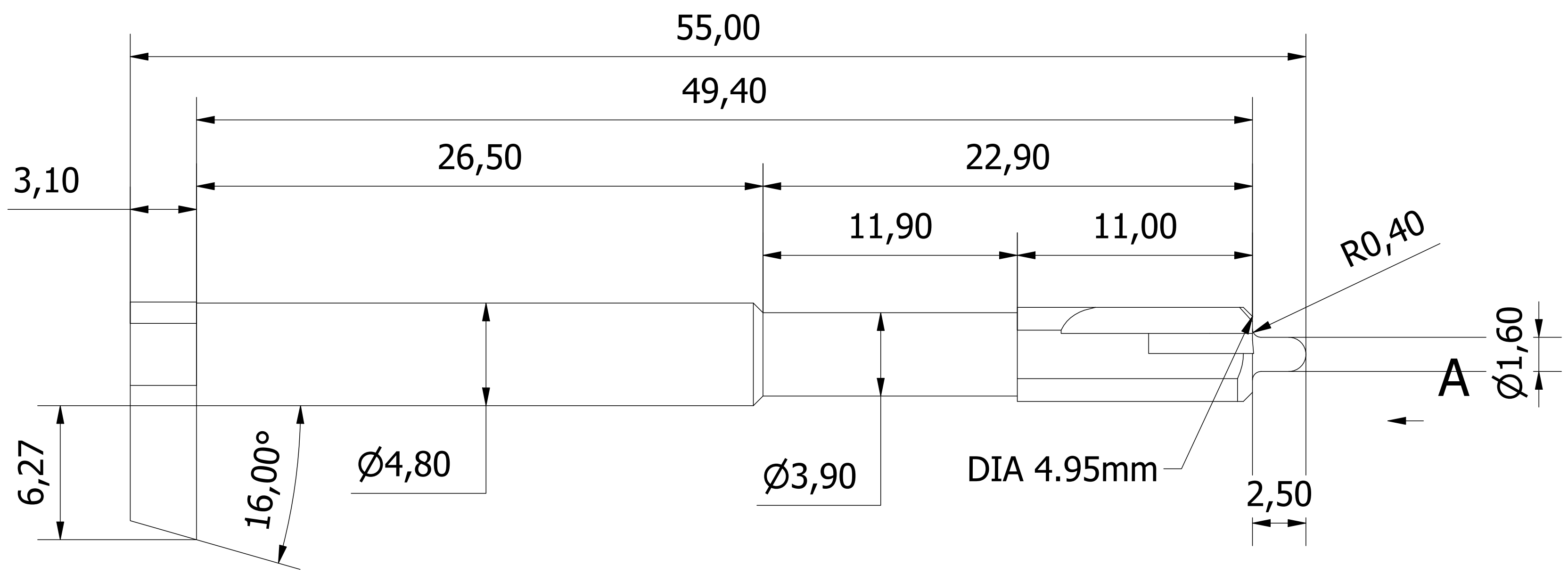
The striker is finished after these steps, and should be deburred by breaking all sharp edges and sanding all surfaces smooth. The striker can be finished by sandblasting it, and it can be parkerized or hot blued if desired, however it can be left as is.

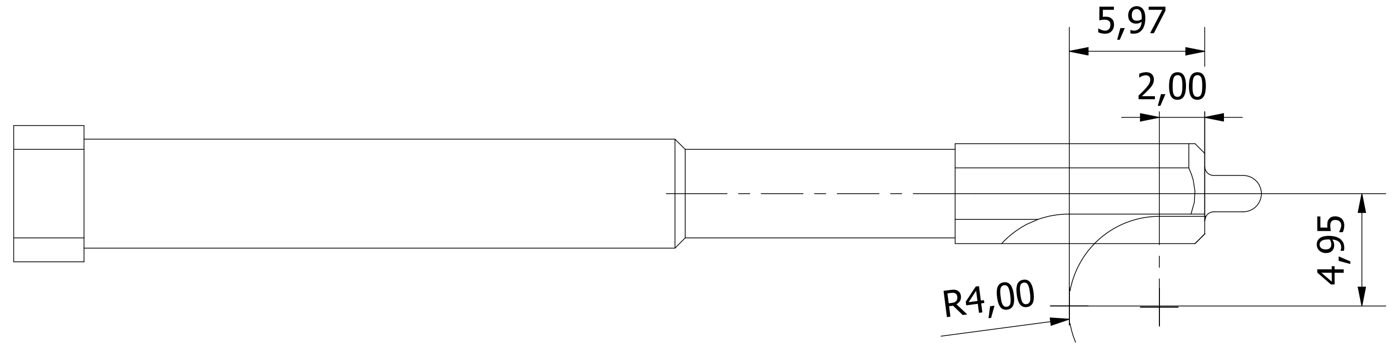
# Firing pin, Glock 19R, round nose

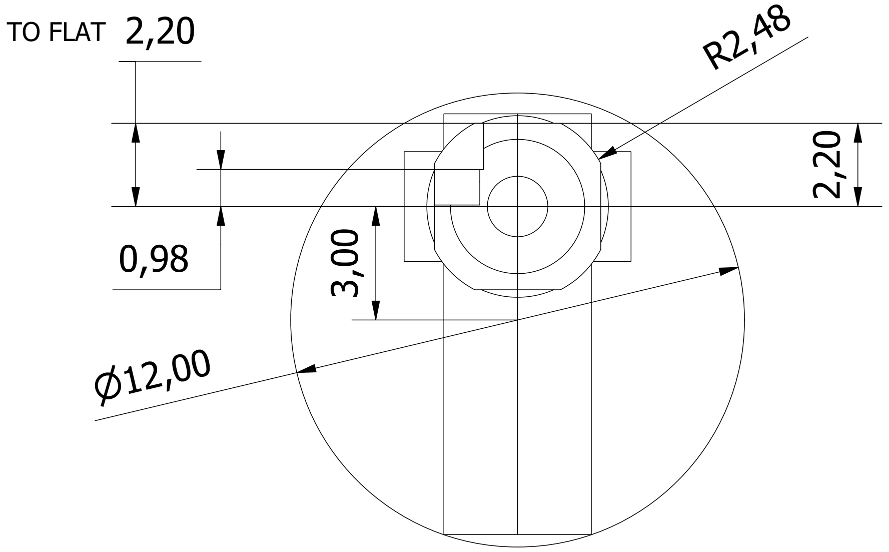
Material: 10.9, G8, 4140QT, O1, 12mm/½" round stock

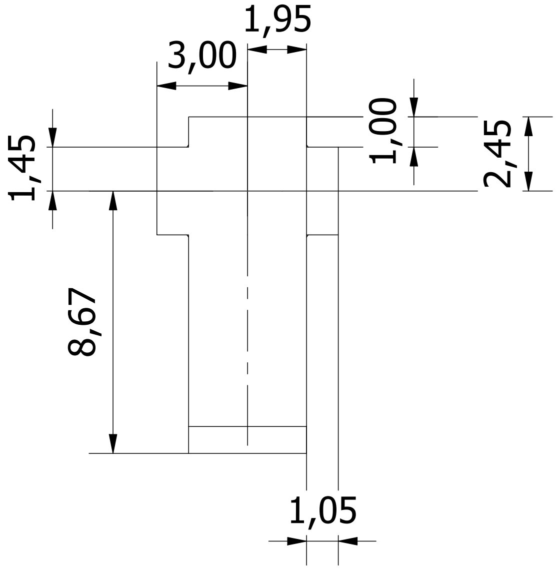
HRC: 35+-5

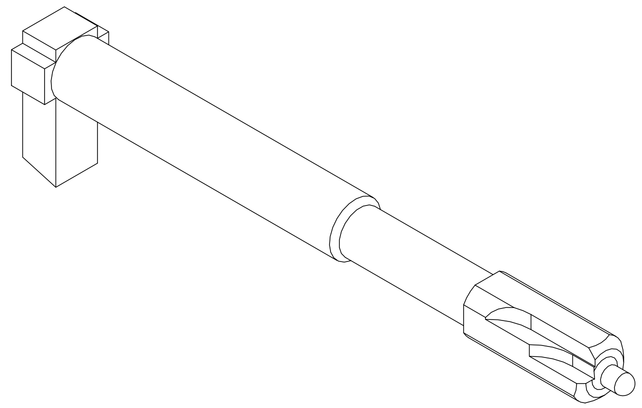
1. Offset by 3mm in collet, drill center holes.
2. Mount between centers, turn allowance to maximum allowed dia.
3. Mount with collet from allowance.
4. Turn firing pin head, round nose with filing or a radius tool.
5. Step turn rest of the shaft to sear.
6. Chamfer edges, deburr and sand.
7. Part off allowance.
8. In horizontal rotary(or square collet block), index to largest offset.
9. Mill sear part general cross shape.
10. Use angle block to mill the angled bottom surface(if rotary, do as last step when unmounted).
11. Insert part from behind to rotary by carefully aligning the sear perpendicular to one face. (Tip: spread marker to smooth plastic, align by pin top surface, rub shaft to create perpendicular line)
12. Mill front shaft flats.
13. Heat treat if necessary, sandblast, surface finish if desired.











Designed by
HWR

Checked by

Approved by

Date

Date
05/09/2022

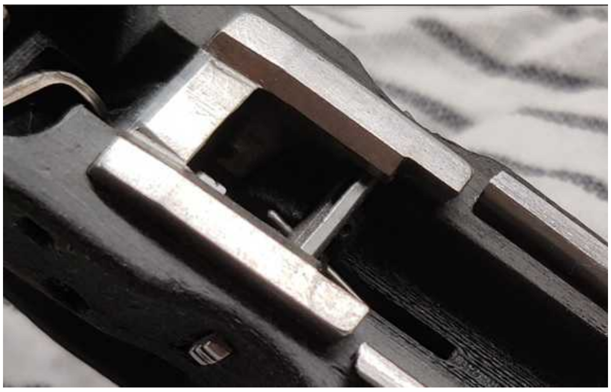
Firing pin, remake

Edition

Sheet
1 / 1

# 5. Locking Block

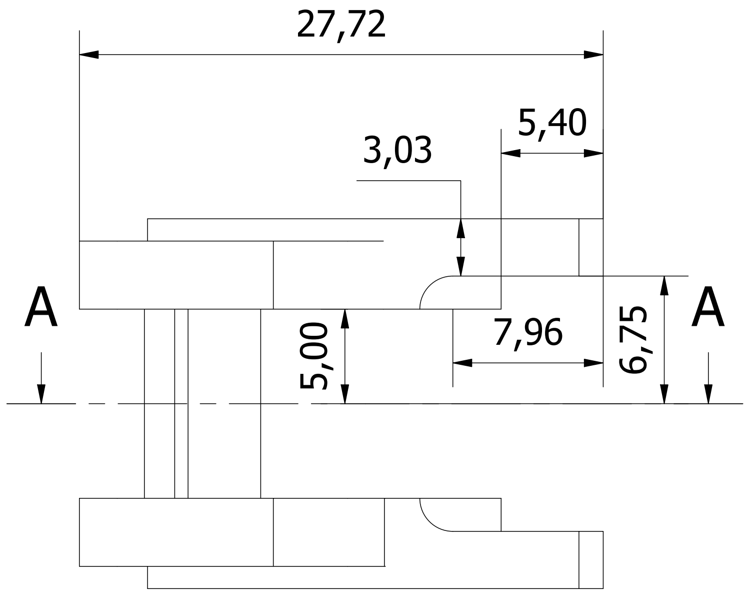
TBA

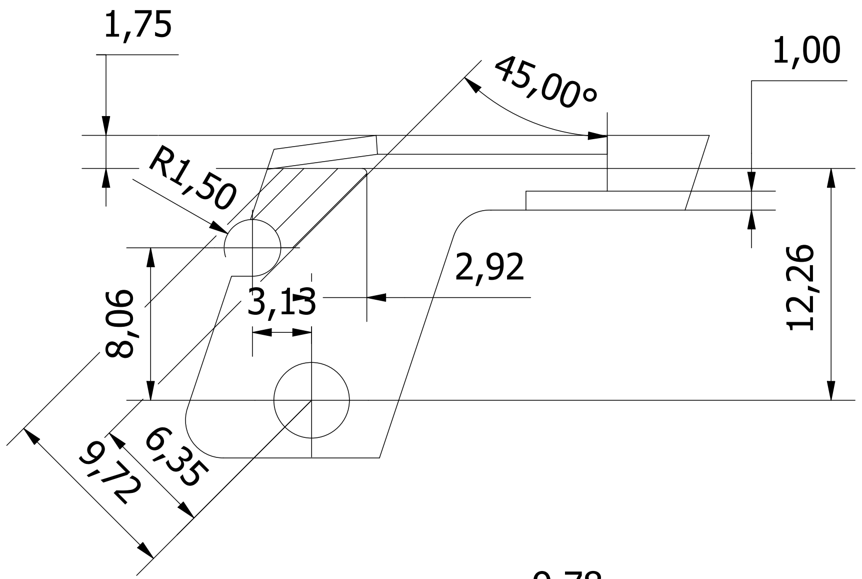


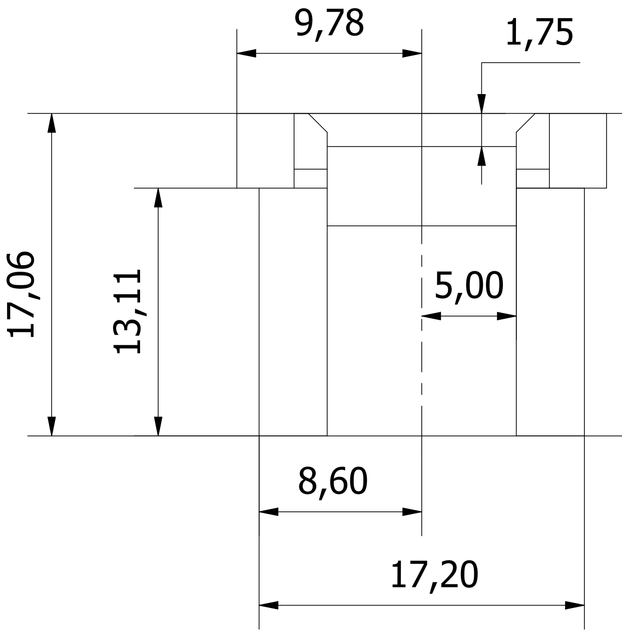
# Locking Block, G19R

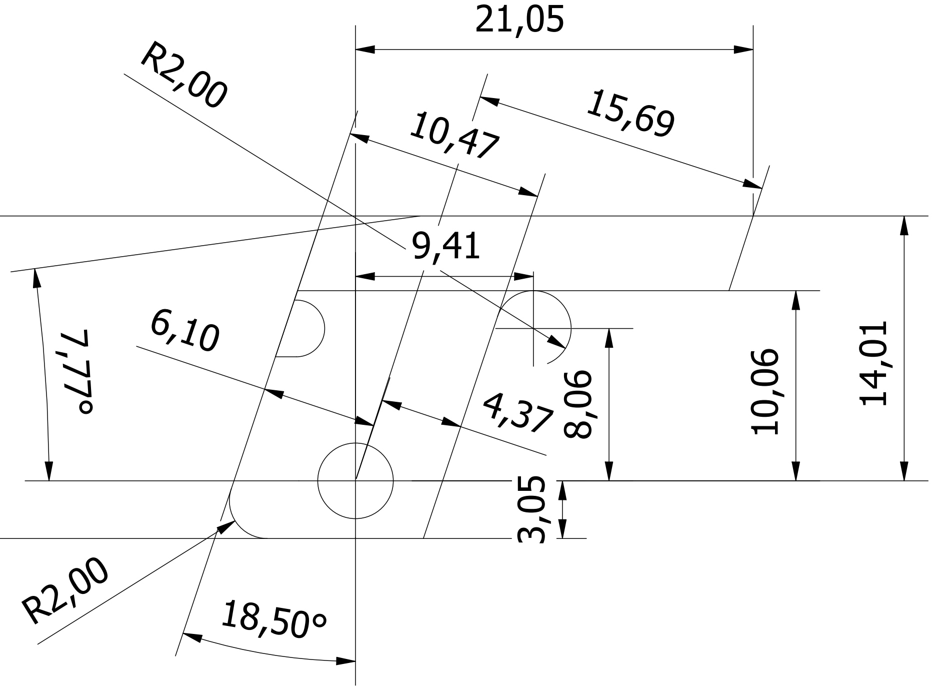
Material: 4140, 40HRC, 25.5mm round stock

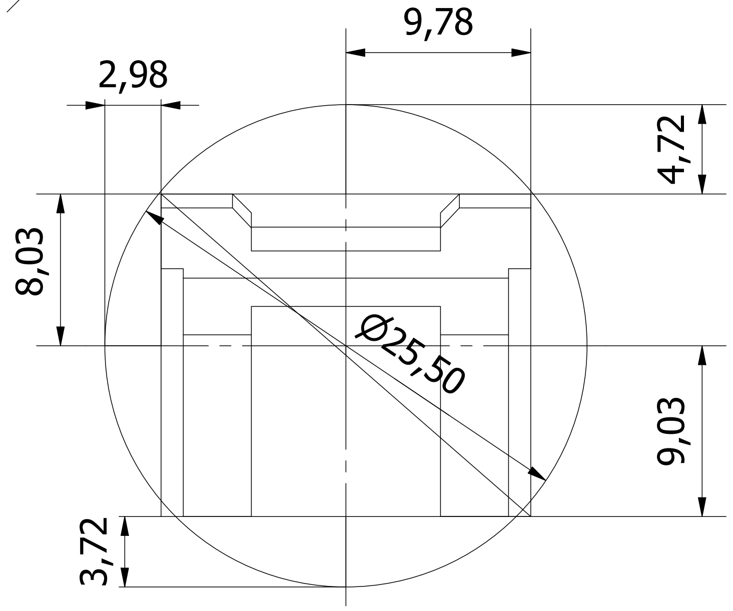
1. In square collet block, mill to rectangular flat acc to inst.
2. Mill out top slot, chamfer.
3. Mill sides to recess.
4. Determine main hole as 0, use gauge pins if necessary. Drill, ream both holes and fork corner.
5. Drill second hole back to D1 from rear hole.
6. Remove material from fork to form 90DEG.
7. Remove inner volume in 45DEG mount.
8. Mill fang slots at 90DEG.
9. Mill fang round slots from below.
10. With 18.5DEG block, mill fork and front L shape.
11. Part off.
12. With 7.77DEG block, mill back slope, chamfer. Mill 45DEG relief to back face of lug.
13. Cut radii to bottom corner.
14. Deburr, rotary tumble.







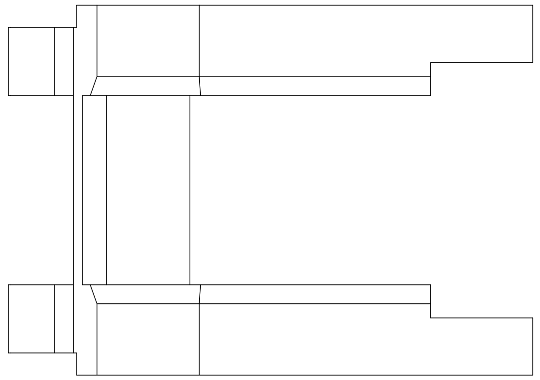


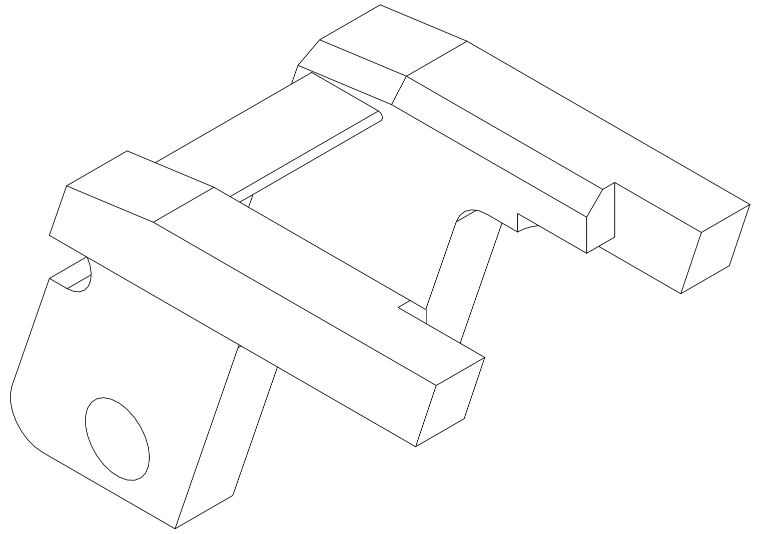


From 25.5mm round stock, remove:

TOP = 4.72mm (8.03mm from C)
BTM = 3.72mm (9.03mm from C)
SIDE = 2.98mm (9.78mm from C)
NOTE

Locking block upper pin hole may not fit directly to commercial design and it is proprietary for the design frame until further notice. The block should therefore be made WITHOUT the second pin hole slot unless proprietary frame is used.





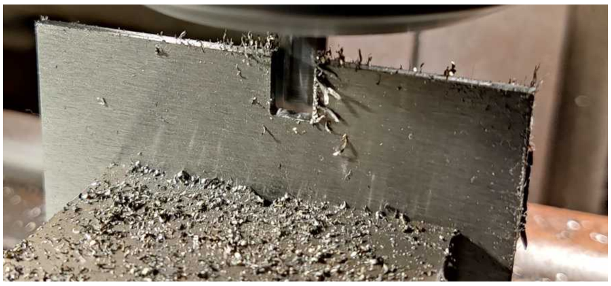
| | | | | |
|---|---|---|---|---|
| Designed by<br>HWR | Checked by | Approved by | Date | Date |
| Locking Block G19R | | | Edition | Sheet<br>1 / 1 |

# 6. Slide Lock

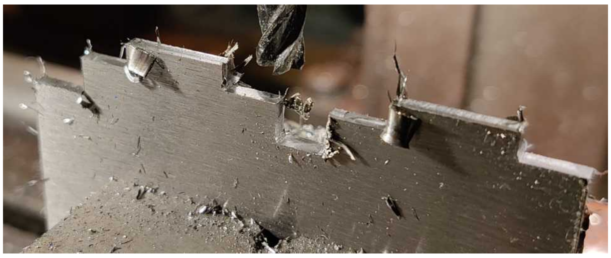
The slide lock is retained within the frame by a torsion spring in a slot, and it is responsible for holding the upper assembly mated and acts as an endstop when the assembly returns in battery. The slide lock will not last if made from mild or unhardened steel, it must be made from heat treatable alloy such as O1, for which 2mm thick sheet works perfect. Any alloy that can be heat treated to between 40-50HRC suits, however, and it can also be made out of prehard material if desired.

The following tools are required for manufacture:

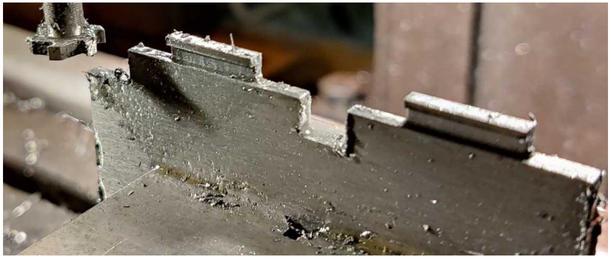
- endmill, 4-10mm
- slot cutter, 2x10mm
- slitting saw (slot cutter can be used)
- chamfer mill (optional)
- slide lock serration cutter (optional)



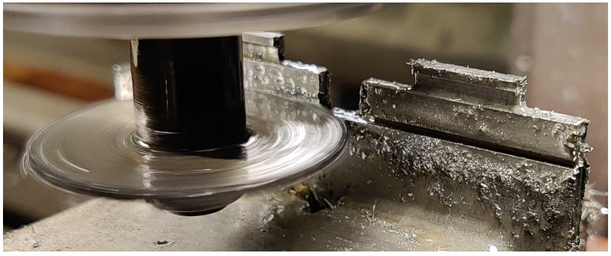
The process is started with clamping a 2mm thick sheet of raw stock of minimum 30mm wide, or more + 1 allowance for cutter diameter for each part. The part is indexed, and milled to form the general profile. Best method is to determine the center of each part separately and mill the dimensions around the centerline, and then move to next part. Several locks can be milled from a longer sheet this way.



The sheet must be engaged with proper care, as thinner sections may cause grabbing of cutter.



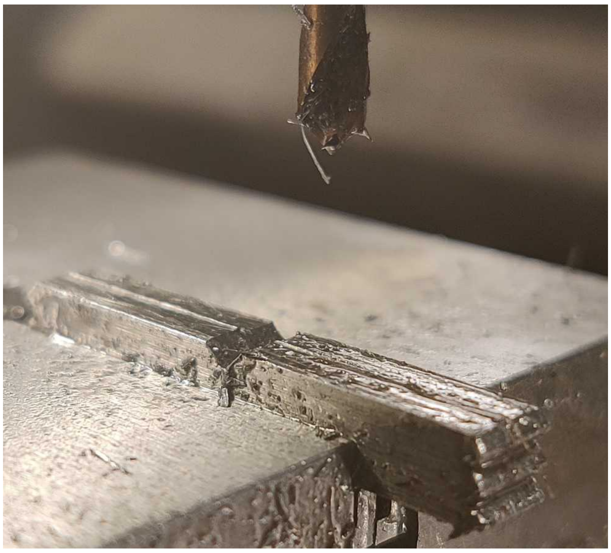
When the profile has been prepared, a slot cutter is used to cut the locking slot. Height can be adjusted when the slot cutter thickness is less than the slot being cut.



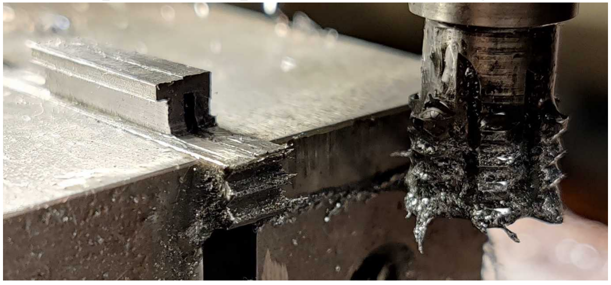
When the slot has been cut, the blanks are ready to be parted. A slitting saw is used to saw off the parts, hence this method allows producing multiple locks height-wise, usually 2-3 locks per mounting before the sheet support becomes insufficient. **NOTE**: slot cutter used prior can be used for this phase in case slitting saw is not available, it only causes slightly more material loss and need for multiple passes.

Parted blanks are deburred by removing any loose burrs and surface sanding the parts in order to allow smooth clamping.

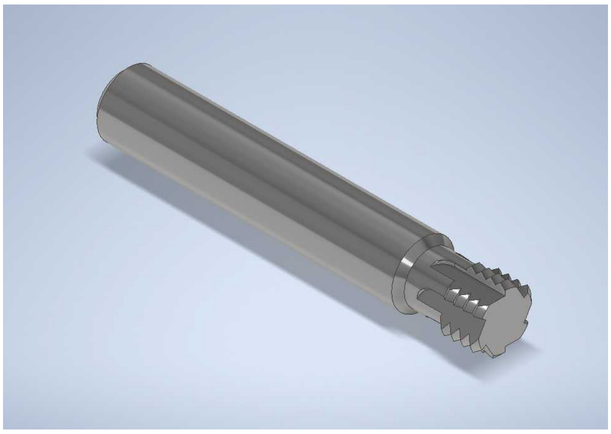
# 6. Slide Lock



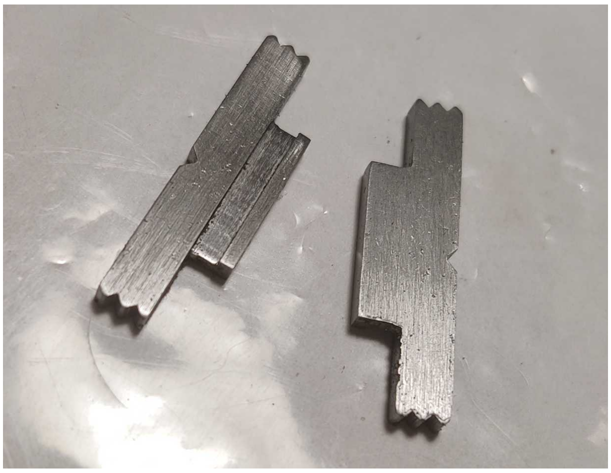
Parts are then clamped for spring chamfer milling. Multiple parts can be ganged this way. Note: the other end is left with clearance from vise for serration cutting following. **NOTE**: This step can be replaced with a triangular file.



Next, with same setup, the first side serrations are cut using the slide lock serrator tool. The part is flipped, as is shown in the picture, and serrations are finished on both sides.



The manufacture of slide lock serrator is presented in the drawings. **NOTE**: This tool can be replaced by using triangular needle file to form the serrations manually, and a hacksaw with fine blade can be used for aid.



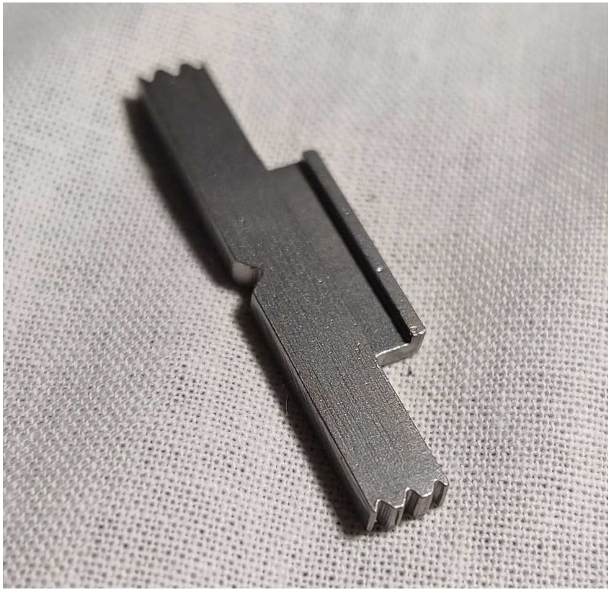
Finished samples after deburring, prior heat treatment. The parts are finished, but being annealed, are too soft for use.

The parts are heat treated with selected method, in case of forgiving alloys such as O1, propane torch can be used to heat them cherry red, and the parts are then quenched in 70-100C thin motor oil. After quenching, the parts are quickly surface sanded to reveal fresh surface, and tempered to purple temper, and then quenched in water. If electric oven is used, the parts are transferred directly from hot oil without sanding into oven at 270-300C, with wiping as much oil off as possible, preferably preventing the parts from cooling below 50C at any point.

## 6. Slide Lock

Austempering can also be used for even tougher parts.

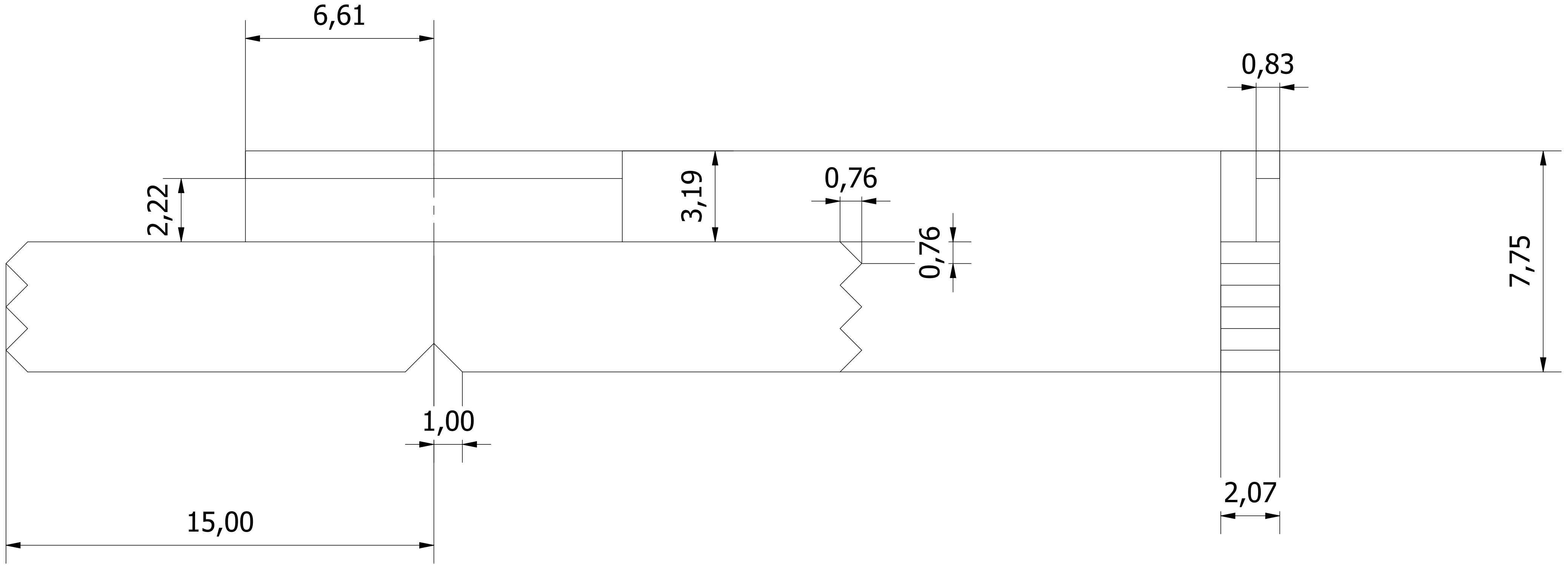
Parts after heat treatment with pre-cleaning, prior tumble finishing.



Finished slide lock.

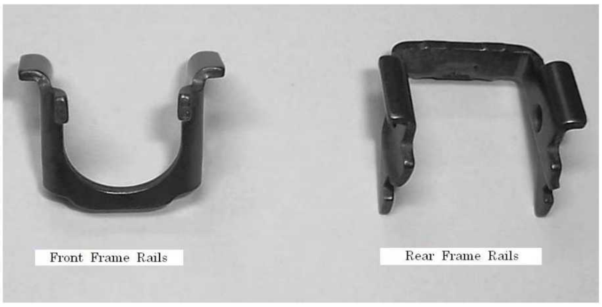
# Slide Lock

Material: O1, CrV



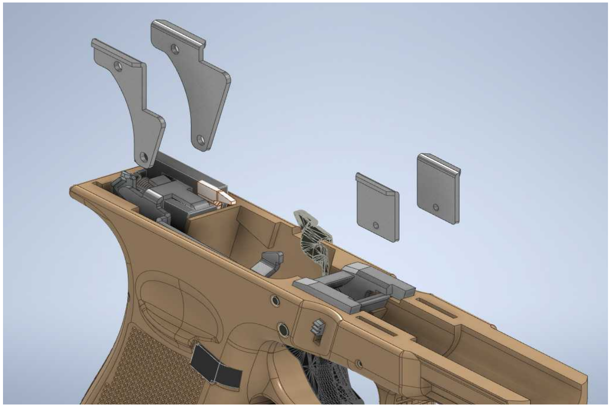
| | | | | | |
|---|---|---|---|---|---|
| Designed by<br>HWR | Checked by | Approved by | Date | | Date |
| | | Slide Lock | | Edition | Sheet<br>1 / 1 |

# 7. Rails

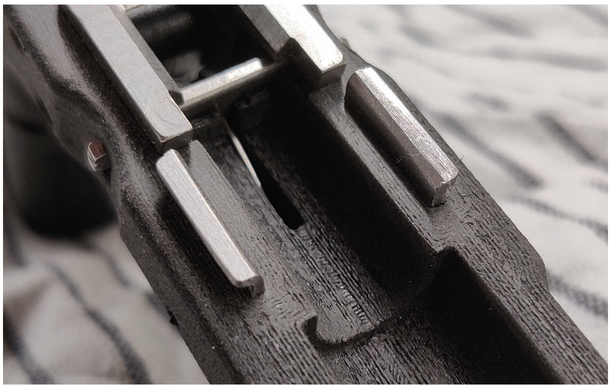


Picture of OEM Glock rail inserts, that are embedded in the injection molded frame. The basic shape of the rails is very simple.

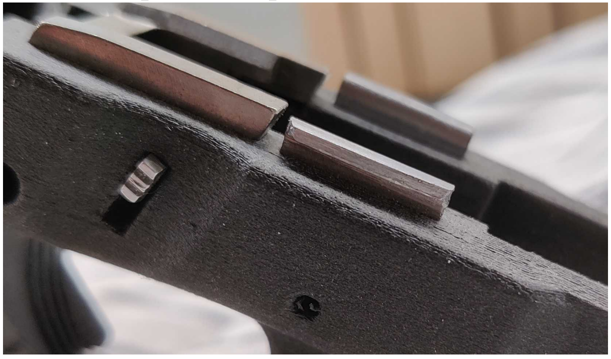
Rail inserts made from steel are needed to pair the upper with the plastic frame. While OEM guns come with injection molded embedded rails, aftermarket products and especially 3D printed frames have separate inserts, that vary slightly by design, but are commonly either machined steel or laser-cut sheet metal bent in shape. The availability of these rails is mostly limited to The United States, and the rails can also cost quite a lot, so a method to manufacture rail inserts was clearly warranted.



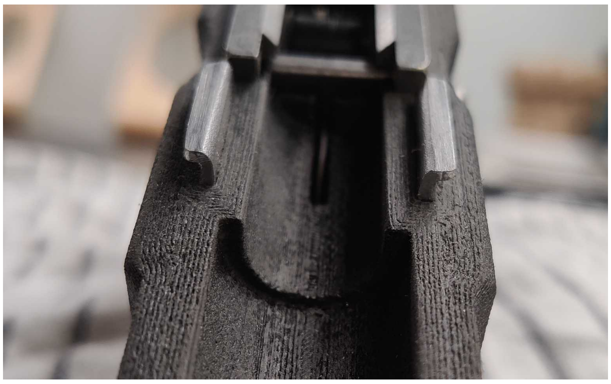
The rail inserts were re-designed slightly in order to make them simple and cheap to manufacture, yet robust enough to withstand the stresses involved. A frame, based on PY2A Glock 19 Gen 3 was used as a template, and converted to adapt the changed rail geometry.



Major changes are made to front rails, which are changed from machined solid heavy block into two, simple inserts, that are pressed in the frame and pinned in place.

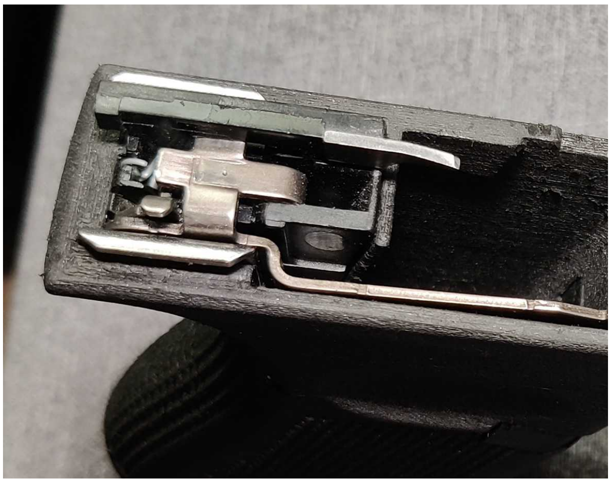


Rear rails are made from two separate parts instead of one, as making two bends proved to be very difficult without expensive precision jigs, that will still require precisely prepared blanks.

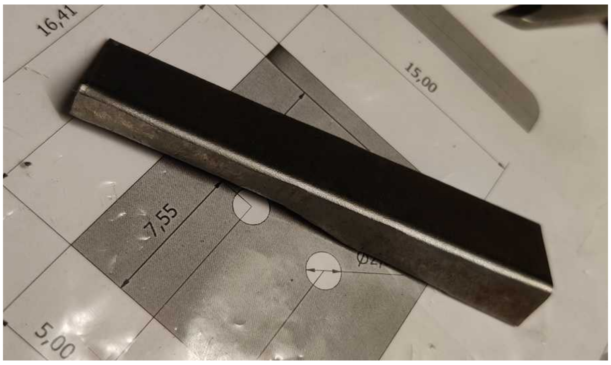


During testing, these inserts have proven to be as useful as those designs.

# 7. Rails



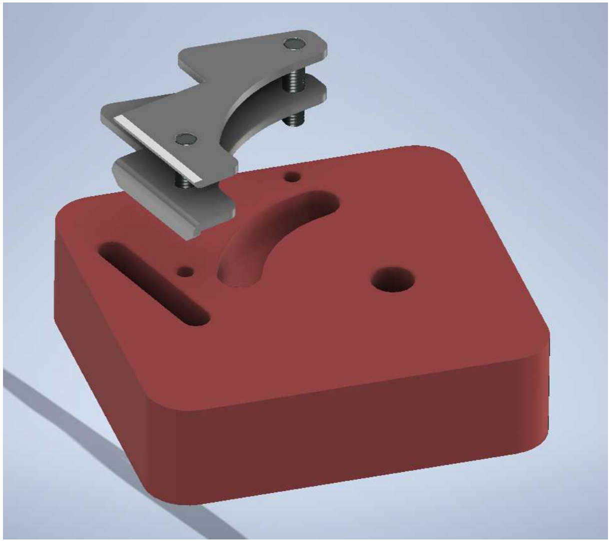
The rail inserts designed for this gun are made from pre-bent 1.2mm steel sheet, and all the dimensions are referred to the edge of the bent. This takes one of the biggest issue, aligning the bend with the features away by turning the concept upside down. Rail inserts are easy to machine, once the bent blank has been formed. Mild steel has been deemed decent for now, and it has the added benefit that the rails will wear down, if this is to be happen at all, instead of the slide, and can be replaced easily and cheaply.



As presented in the pictures, the original rail preparation was started with scrappings of a sheet metal, and the bend was done using a sharp jawed vise – and a hammer. By carefully, and gradually tapping, a sharp 90 degree bent was produced, that was hammered flat against the jaws, and the blank was ready for milling.

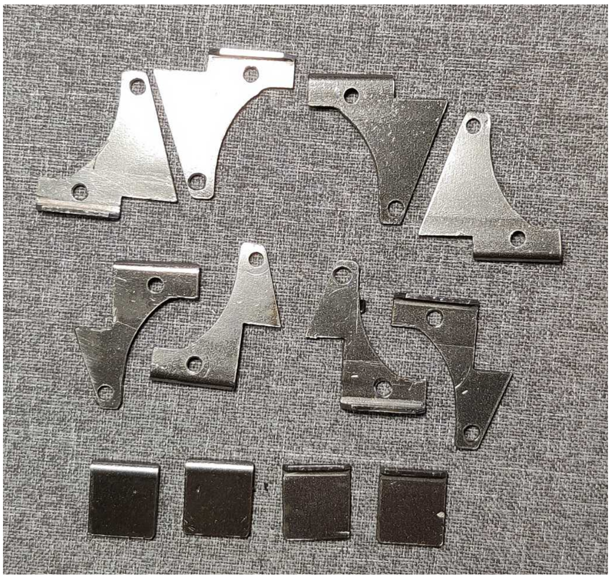
The rails were milled true first, and then cut into pieces using angle grinder. The silhouette of the rails from all straight surfaces are milled to spec, using the mounting hole as the datum. The mounting hole is positioned using the rail top surface as datum, and once the hole is drilled and reamed to spec, it is used as datum to cut all other shapes for the rail. The second hole is drilled and reamed only for mounting the rails for milling jig, and it serves no purpose after that.

The rail edges can be chamfered using either simple 45 degree mill, or corner rounding mill.



The round back of the rails is cut using this included rail milling jig, with which both rails as a pair can be milled as mirrors. The rails are mounted to the jig as referred to the picture and clamped using two hex key bolts. The bolts should be tightened with care, as the plastic will bear only limited amount of torque until giving away.

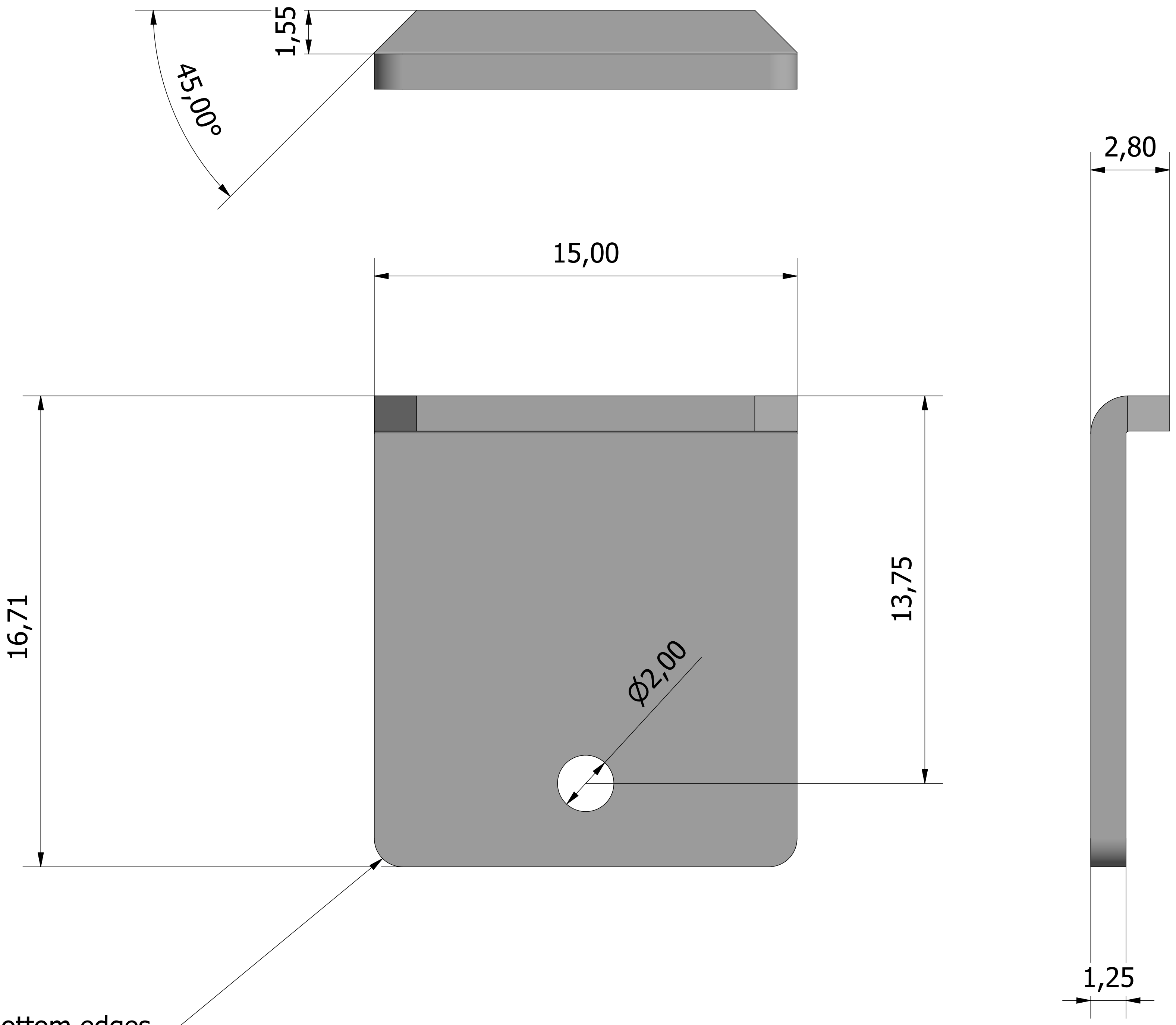
The hole in the jig is the datum hole, with which the tool is indexed to a rotary table. The rail rounded backs are cut to given radius, and after which the rails are finished and can be deburred.



Set of rails, after preparation, before finishing. Note the holes lacking from the front rail pieces, which were included later.

# Glock 19 Front Rail UNI

Material: Steel, stainless steel



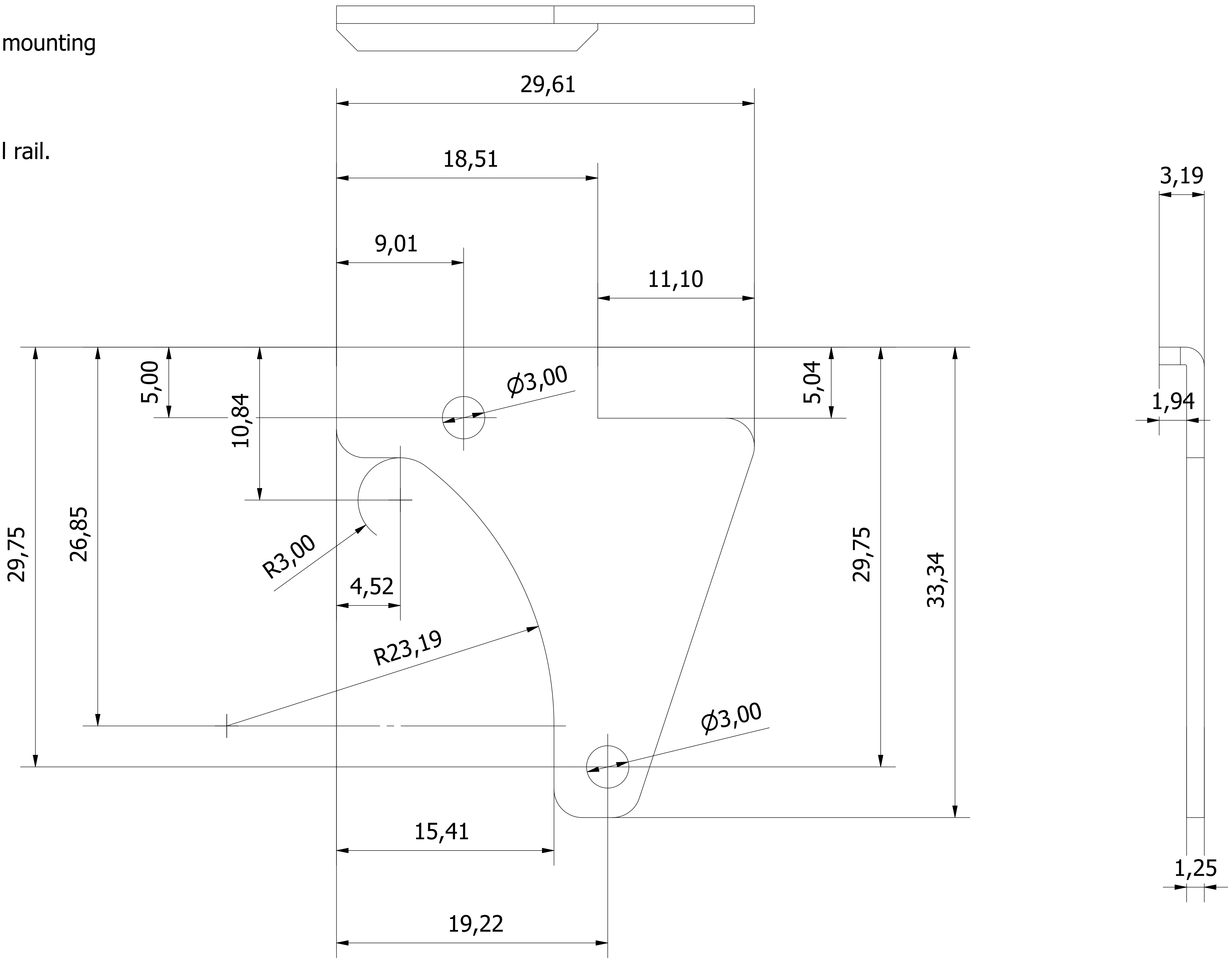
Break all bottom edges
for press fitting ONLY

| Designed by | Checked by | Approved by | Date | Date |
|---|---|---|---|---|
| HWR | | | | |

| | Edition | Sheet |
|---|---|---|
| Front Rail UNI | | 1 / 1 |

# Glock 19 Left Rear Rail

1. Bend blank with allowance for mounting
2. Mill general shape.
3. Drill, ream holes.
4. Re-mount, mill rail side.
5. Mount sideways, R2 corner mill rail.
6. Mount to Mill Jig in rotary.
7. Mill radius.
8. Mount mill jig to vise.
9. Mill side slope.



| Designed by | Checked by | Approved by | Date | Date |
|---|---|---|---|---|
| HWR | | | | |

Left Rail

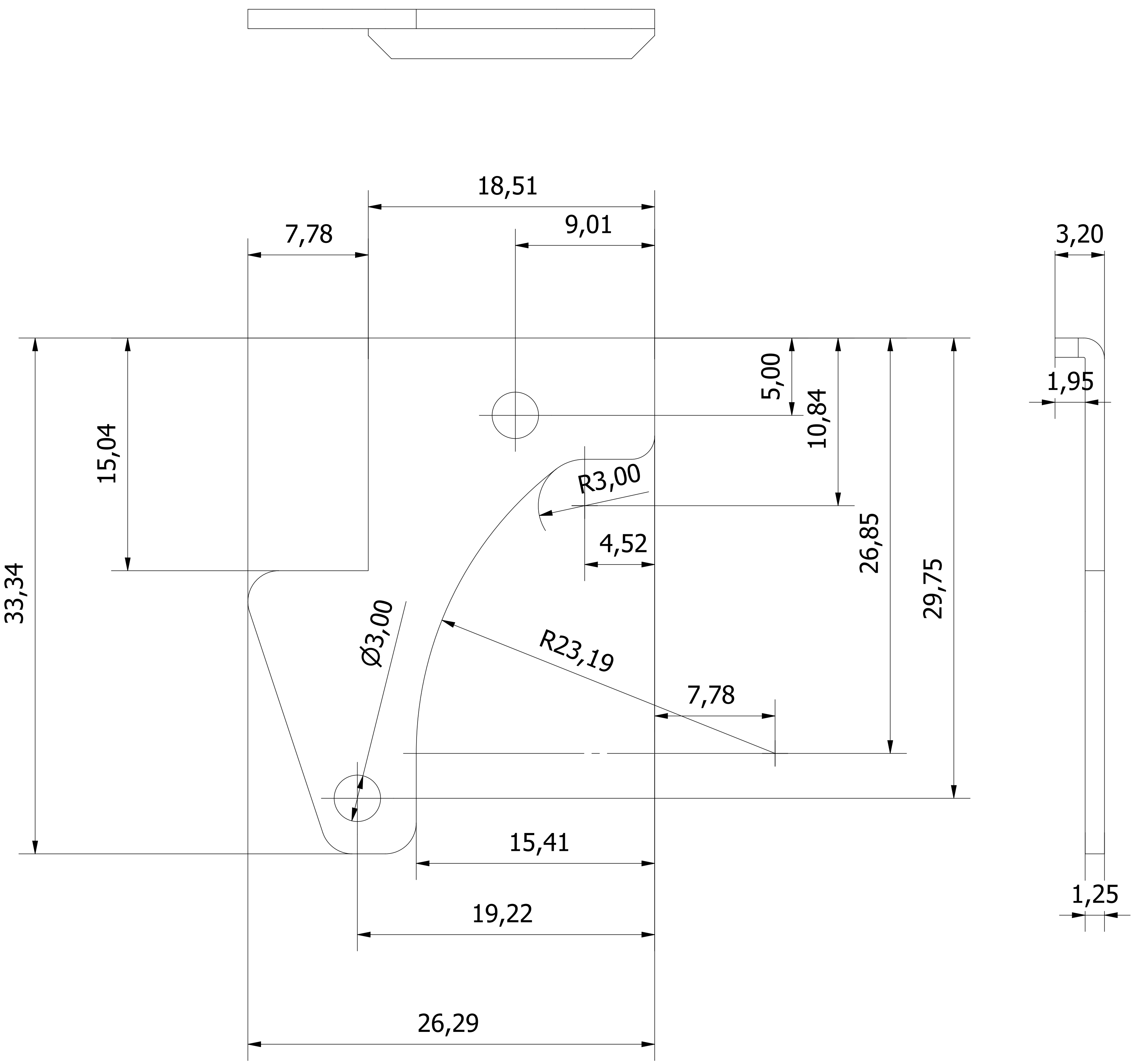
Edition

Sheet
1 / 1

# Glock 19 Right Rear Rail

1. Bend blank with allowance for mounting
2. Mill general shape.
3. Drill, ream holes.
4. Re-mount, mill frontal step. Mill rail width.
5. Mount sideways, R2 corner mill rail.
6. Mount to Mill Jig in rotary.
7. Mill radius.
8. Mount mill jig to vise.
9. Mill side slope.

NOTE: Bottom and side corners can be broken without tolerance.



| | | | | |
|---|---|---|---|---|
| Designed by<br>HWR | Checked by | Approved by | Date | Date |
| | | Right Rail | Edition | Sheet<br>1 / 1 |

# 8. Extractor

TBA

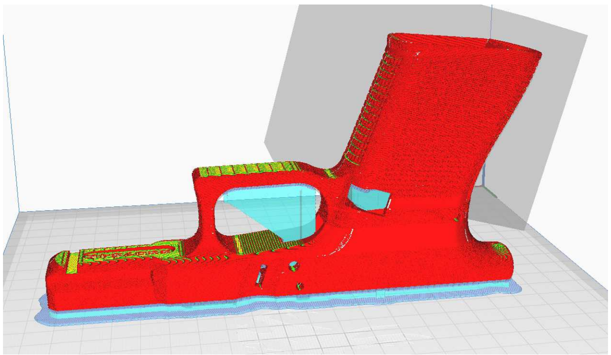
# 9. Frame

***Finished frame:*** *the features above rails are not included in the final edition, as they make printing rails down more complicated and offer little benefit for functionality of the assembly.*

The Glock 19R frame is compatible with all other commercial Glock parts, except slide lock spring, and original rails.

**Printing a frame**

Proper settings and materials are needed to 3D print a durable and dimensionally accurate frame that has good surface finish. The frame that is incorporated with this design is a derivative of PY2A Glock 19 Gen 3 pistol frame, with slight modifications.



The exact print settings for the frame are included below. Material used is PA6CF, Polymaker or Fiberlogy as the manufacturer, with recommended temperatures. Print orientation is rails down, with a raft, and using conical support to minimize support volume. A support blocker is placed in the grip area as presented in picture below to prevent excess support generation. Print time for the frame will be around 48 hours. The frames presented in this manual are printed with stock Ender 3 printer with original glass printing surface.

The filament is prepared by drying it in oven at 80C overnight (12 hours). The filament is transferred directly into a moisture resistant enclosure with desiccants, and an insulated tube is used to direct the filament into the printer to minimize moisture absorption.

***Finished print:*** *an adhesive tape was tested and showed improvement in bed adhesion. Depending on manufacturer adhesives may not be necessary.*

An adhesive two-sided tape was used experimentally to aid bed adhesion, which may provide complications using nylon print materials. In these tests, two-sided tape eliminated initial bed adhesion issues.

**Deburring and support removal**

Finished frame is de-supported by carefully removing the supports using pliers, punches and wood cutting chisels. Supports should be removed by carefully wedging the chisel between the interface and prying, until cracking can be heard, and the loosened supports can be removed using pliers. With proper settings, the supports detach without damaging the parts, and care must be taken not to damage the frame. Any burrs can be carefully cut or shaved off to improve finish. Support interface is relatively smooth with proper gap and interface infill and pattern, and may not need any further finishing, such as sanding, shaving or filing. Small punches may be useful for removing supports from holes and internal cavities, as is small razor knife. Do NOT drill any holes to deburr them, as the press-fit pins may not be retained if the holes are enlarged.

**Annealing: water curing nylon**

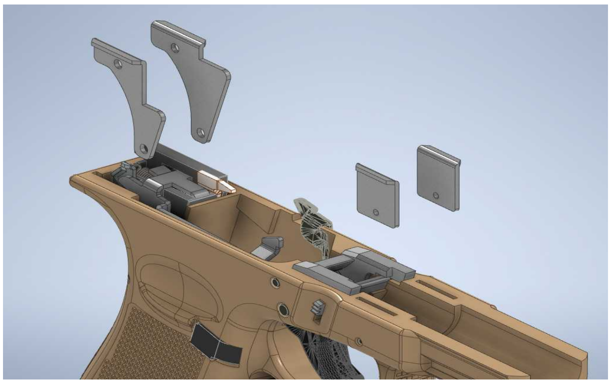
PA6 is hygroscopic plastic, which changes it's properties when it is saturated with water. This equilibrium is established naturally over days to weeks under atmospheric conditions depending on humidity and temperature of the climate, but this process can be sped up by soaking the parts in 70C water for 15 minutes. This process changes the plastic properties, lowering it's ultimate tensile strength, but increasing toughness up to 3-fold.

If the manufacturer has recommendation for thermal annealing, this process must be done prior. General procedure for PA6CF is 90C for 2 hours, with natural cooldown.

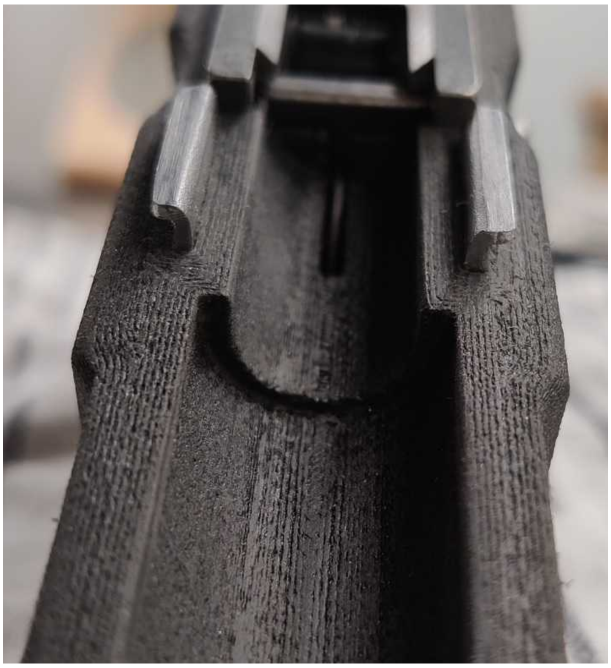
After the frame has been processed, it is left to dry.

**Assembly**

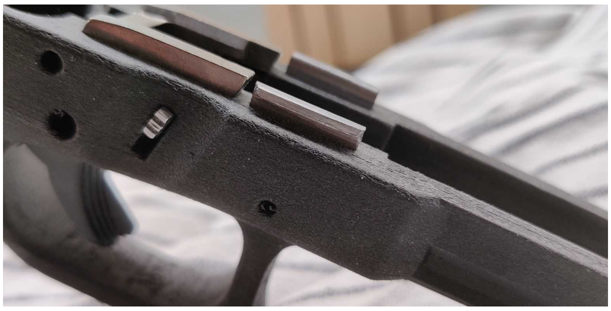
The frame assembly is fast and easy to do when all parts have been acquired. The assembly starts by pressing in the rails.



**Front rails**



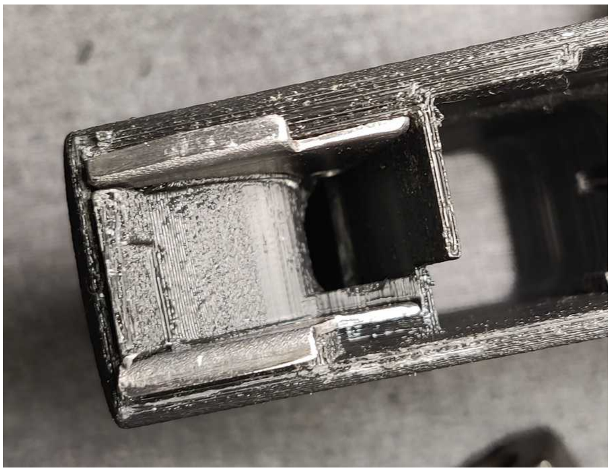
The front rails are identical, and they are designed to be embedded into the plastic frame permanently. For this purpose, they retain a press fit, and the rails should be first engaged by hand and tapped using small rubber hammer, and pressed to final depth using a vise or other controlled method to prevent misalignment or damage to frame or bending the rails. Prior pressing, make sure the slots are clear of burrs or possible support pieces by scraping them with a piece of piano wire and by checking visually the slots are clear.



For securing the rails, a securing pin is used to lock the rails down. For properly made rail inserts, the pin should be tight but easy to press through the frame using a vise, and retain a secure fit to the inserts. If desired, epoxy glue can be applied to the rails before pressing them in.

# 9. Frame

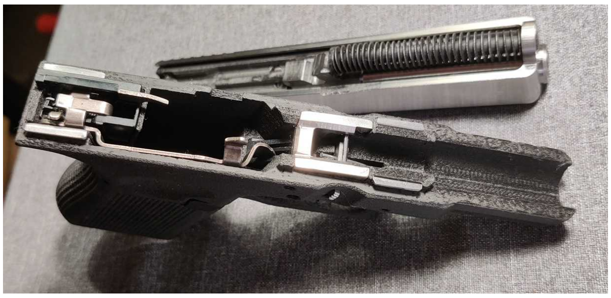
**Rear rails**



***Rear rails:*** *Genesis version, hand-made, but working samples of rails.*

Rear rails should have slight press fit, but they are primarily retained in place by aligning them between the frame and the trigger housing unit, and locking them in place with a single pin. This pin is pressed in place only after assembling other parts.

**Parts assembly**



When the rails are fitted, rest of the parts can be installed.

**Magazine release and magazine well**

Visually check and deburr magazine well first, and test free fit with a magazine prior assembly.

Magazine release button is first inserted into it's slot and tested for free actuation. If the magazine release button does not actuate freely, it may be necessary to sand the button and make sure the magazine release slot is deburred and smooth. Running a razor blade or a small square needle file may be necessary if there are visible burrs.

The magazine release actuates with one straight 1.3mm piano wire, that is inserted down into a slot, and the magazine release button is slid in place from larger opening, and with aid of a punch, the wire is moved slightly back to allow full insertion. After this, the wire head is pushed so it drops into the slot in the magazine release, and it should snap in place and actuate the magazine release when pressed, and promptly return it back to initial position. The operation is tested by inserting a magazine, which should snap in place and remain there when tried to pull out of the gun strongly, but release and drop out when the magazine release is pressed. If the magazine faces friction or resistance, it may be necessary to deburr the magazine well. Remove magazine before further assembly.

**Locking block, slide catch and trigger assembly**

These parts must be cross-installed in such order that the trigger group is pressed into the frame first, and then the slide catch is placed and held in place, while the locking block is pressed down to it's slot. The slide catch has a spring, that must fit below the locking block.

When parts are fitted, a 3mm punch is inserted through the trigger pivot hole to align the three parts. Trigger may need to be pushed upwards to align it – do not apply force. When everyhing fits, remove punch and insert 4mm pin to the hole, and either use a vise or a small rubber hammer to drive the pin through the frame. Constantly monitor that all three parts are aligned. Do not try to force the pin in, as it may damage the parts or the frame. Wiggle the parts if necessary, until the pin fits. The pin should have tight but easy fit.

When pressed in place, press in the upper pin in similar way. Make sure the slide catch spring does not interfere with the pin, and use small punch to push it if necessary.

Make sure the rear rails and the trigger housing are aligned by driving a punch through the hole, and then press in the third pin using similar methods. If necessary, use punch to tap it to final depth.

**Slide lock**

# 9. Frame

Finally, check slide lock slot for any obstructions and deburr if necessary. The slide lock spring pin is pressed down into the hole in front of the locking block, so it remains upwards tilted over the slide lock slot. From side, slide the slide lock so the claw faces backwards, and by using a punch, press down the spring pin so the slide lock can be slid in place. The spring locks the slide lock in place, and it should actuate up-down when pressed from sides.

Take the full upper assembly, and slide it from front so it mates with the rails, and carefully pull it back. If there are obstructions, try wiggling the slide, but do not apply force if the slide does not fit, but check for issues of alignment. When properly assembled, the slide should freely slide and audibly snap in place, and when cocked, it should engage the trigger, and when the trigger is pressed, an audible click is heard. Trigger has a long, springy pull, as it engages the striker and charges it, and a noticeable wall is felt, until the trigger releases the striker.

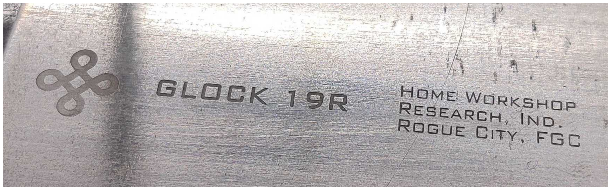
**The gun is now operational.**

**Issues**

While properly printed frames from good materials have shown to be very durable, printed frames are still inherently weaker than injection molded, fiber reinforced polymer frames. The most common failure modes for 3D printed Glock frames are cracks at locking block pin holes, or frame splitting from the axis between magazine release and rear rail – trigger housing pin. Therefore it is recommended to check the frame for cracks or other modes of failure frequently.

# 10. Engraving

While engraving is not a necessary feature and can be skipped in order to save time, for finishing the gun it adds to the aesthetic value.



A method based on PCB etching was developed for the purpose, and found to work well for the purpose. The method is based on electrochemical etching, and equipment for ECM can be directly employed for this purpose, although at the simplest, a DC power source of under 6 volts, ideally 1-1.5 volts, and a cotton swab can be used. Required masks, vats, printing instructions and other details are provided in the files.

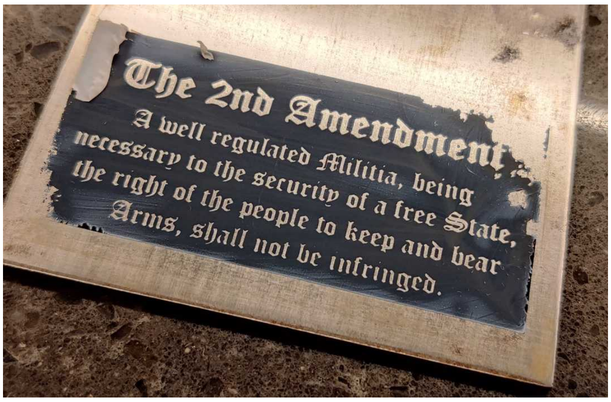
A mask is printed using an inkjet or a laser printer. A negative image is created, and the image is mirrored, as it is transferred to a surface. High gloss photo paper suits best, however, glossy magazine paper works most of the time and can be taped to an ordinary copy paper to support it during printing.

The surface is prepared by sanding it smooth with minimum 400, but up to mirror finish. The surface must be free of defects such as scratches or pit corrosion, or the mask will come out perforated, and while blank areas can be filled using nail polish or any waterproof lacquer, text is basically impossible to fix due to it's intricate nature. After sanding smooth, the surface is wiped with acetone to degrease it, and double wiping is recommended to eliminate cross contamination.

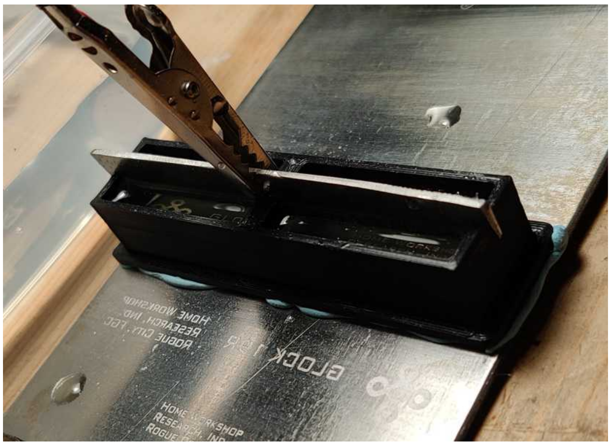
The mask is aligned and placed carefully onto desired position, and a flashlight can be used to see the silhouette to aid placement. A backing paper from normal copy paper is used to prevent backplate adhesion. Finally, a backing plate with minimum thickness of 2mm, preferably 5mm, is placed on top, and clamped down so that there is a clamp pressing on every 3" distance minimum. Pressure can be applied liberally, as too low pressure will cause adhesion issues.

The clamped assembly is then heated in oven, until the core temperature reaches 128C, +- few degrees. Thermoprobe placed direclty on top of the plate gives decent estimates. Ideally, a backplate with thermoprobe hole is used to control temperature, however more rudimentary methods were found to work decently.

When the temperature is reached, the assembly is removed without hurry and cooled down by rinsing it with water. The clamps are detached, and the backing plate is removed, and the part is submerged in lukewarm water. The photo paper is carefully peeled off, starting from an edge, and the ink mask should remain to the metal surface.


The 2nd Amendment
A well regulated Militia, being
necessary to the security of a free State,
the right of the people to keep and bear
Arms, shall not be infringed.

In case the mask has rippled edges or holes in blank areas, they can be filled using nail polish or any fast acting waterproof lacquer. In case there text or symbols are damaged, the mask can be easily wiped off using acetone, and the process repeated, hence re-application must not be hesitated if even the smallest of defects are noticed. Most common reasons appear to be either improperly cleaned surface or surface with defects, too low clamping pressure or too low heat. Toner melts between 100C and 130C, and even lower end range has provided successful transfer without defects. Too high heat may cause toner flow, which may flaw letters and symbols. During tests, the process was found to be quite reliable when each step was followed.



When the mask is ready, it is wiped dry, and a purpose printed vat is pressed to form a pool. Blu-Tak was used as seaming mass and provided to be excellent barrier when pressed down to form watertight sealing. Care must be taken all surfaces within the vat are protected by mask, or fixed with lacquer.

The anode (+) is grounded to the part, and cathode (-) is applied to the electrode in the vat. 1 volt is used for the whole process, and voltage may have to be increased especially at the beginning to break the oxide or residue layer commonly adhering to the exposed surfaces, but commonly only up to 1.2 to 1.3 volts is ever needed. Current for slide etchings was around 50 milliamps, but for small text etchings the surface area is so small the device with 1 milliamp accuracy may not even register, although bubbles can be observed at the cathode. Using higher voltages may cause mask dethaching and much coarser surface finish.

Runtime is 20-30 minutes, and 25 minutes was used in the end. With same surface energy, the surface area determines the current, so same voltage and same time can be used for basically any sized etching, and the time determines the depth of etch.

**Magazine paper transfer method**

This method instructed for PCB toner transfer was attempted using different temperatures and print settings, however, while the mask worked and the backing paper was significantly easier to peel off – as it basically falls off when exposed to warm water - it was proven to be much more sensitive to temperature and pressure variations, and as the backing paper is not rigid enough, applying pressure can cause the letters to offset, making slightly misaligned or stretched letters, and also the etch edge quality was noticeably coarser. Hence it is recommended to use thick high gloss photo paper only for creating etch masks for etching steel.

### Dry film resist

This method utilizes a special resist film, that is applied to the surface of the part, and the design printed on a transparency is placed on top of it, and the film is exposed to UV light, causing curing of the unexposed areas, and depending on nature (positive or negative film), the areas either exposed or unexposed are dissolved in basic solution, and the etching is commenced as usual.

# 11. Finishing

Finishing a part is crucial step in completing an assembly that is both functional, aesthetic and ergonomic, and given it's small benefit compared to time and resources used, it is mostly skipped in DIY gun production. It is hence possible to skip this chapter, as it provides little to no functional benefit over short term, however, properly finished assembly will last longer in terms of corrosion and wear resistance and obviously look better.

The major exception is shot peening. Further description follows.

If no other finishing procedures are undertaken, it is highly recommended to perform basic deburring on part, that will remove and break any chips and sharp edges and rough surfaces, as this will make the parts safer to handle and fit better.

Two final surface treatment methods are described in depth here, hot caustic bluing, and parkerizing. Bluing method involves an alkali nitrate and a caustic with added water, while parkerizing uses phosphate reaction. Bluing uses higher temperature and relatively more dangerous chemicals, and produces a finish that is not as resistant and durable as parkerizing, hence emphasis is given on the latter. Nickel plating is also described, as it can be more lucrative for certain parts.

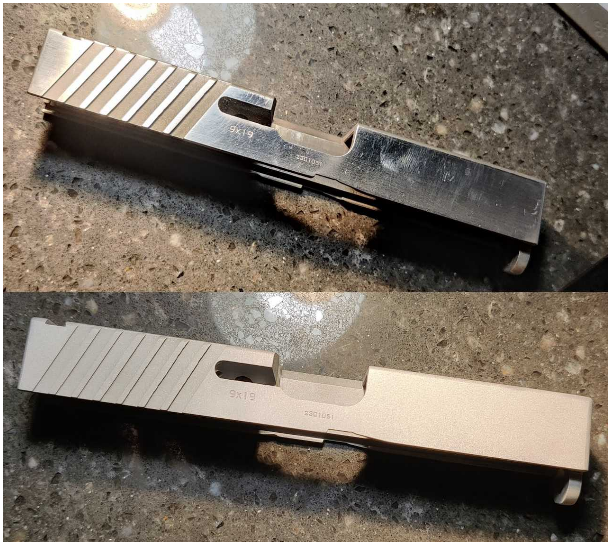
Methods described here include following:

- Manual polishing
- Surface sanding
- Abrasive blasting
- Tumble finishing
- Acid etching and electropolishing
- Hot bluing and parkerizing
- Nickel plating

The most common way to deburr parts is to use manual grinding tools, like sandpaper, files, wheel grinder or buffing wheel. These are very fast and effective at removing obvious burrs and sharp edges, however liberal application may result in uneven finish, and grinding critical surfaces too hard may cause them to become non-parallel or off spec.

Hence, whenever possible, it is recommended to use surface sanding. In this instance, a sandpaper of gradually finer grade is simply placed on a flat surface, ideally on a surface plate, or to an improvised one utilized from polished granite slab. The parts are slided against the surface with linear, steady movements, keeping the ground surface parallel to the plate. This will even out any high spots and burrs, and create a flat face, resulting in finish similar to a surface ground part and is a very effective way to quickly deburr and produce interim finish to parts during production. Sandpaper will remove only hundreths of a mm during a brief session, so parts usually do not lose specs when ground, and toolmarks and cutter marks can generally be completely removed without any issues.

**Abrasive blasting**



A better, faster and a much more uniform method is abrasive blasting, commonly known as sandblasting. A grit, preferably aluminum oxide, is blasted using compressed air towards the part, and the individual grains will abrade the part in a similar manner to sandpaper – as same aluminum oxide grit is used in them as well – but the effect is not restricted to planes, but can instead easily reach any crevices, slots, holes, edges and shapes of any type, and deburr, remove any rust, scale or other residue. Ordinary sand, while cheap, is not very effective at surface treatment and should only be used in large scale rudimentary operations; for small parts blasting, aluminum oxide is mandatory, and the cost is beared only once, as the media is colleceted in the blastbox and can be recycled several times without losing any effectiveness (even up to 100 times). For satin finish, glass beads of 100um or similar should be considered;

they are much less effective at cleaning or deburring parts, so aluminum oxide blasting should be carried before glass bead blast finishing.

Aside of grit, blasting can also use other media, such as beads. Glass and steel beads are used in shot peening, that can act as an abrasive and finishing process, creating fine satin finish, but also creating residual surface compressive forces in the base material, greatly limiting crack propagation and stress raisers from forming. Shot peening is commonplace in all critical industries, including pressure bearing gun parts such as bolt lugs, which are treated for this reason. Shot peening is always the final procedure before applying surface finish, such as bluing or plating, and the benefit will be lost if the surface is ground, or even etched too long.

A suitable sandblasting system can be easily constructed from a plastic, transparent box, into which a set of 3D printed parts are used to create glove opening and ball joint mount for the blaster. An ordinary silent air compressor works great as power source, and a commercial handheld sandblaster gun with top hopper tray can be used; a steel tube of 3-4mm ID and desired length, usually 20-30cm, is attached to the muzzle, and through this the abrasive is ejected into the box, allowing it to act as contained system. An opening for small HEPA filter – or simple filter cloth – is made to the back wall, so the pressure can equalize without losing any grit. For small parts, pressure of around 3 bar is effective, and is also the upper limit when using glass beads or performing shot peening. Higher pressures will consume a lot more air, and while being more aggressive, can be so to a detrimental effect with small parts.

Parts that contain sensitive surfaces, such as barrels, should be protected, and barriers like simple taping over, or using 3D printed end plugs (included) with a threaded rod clamped through the bore, must be used. For glass bead peening, barrel doesn't have to be protected, but direct impinging to rifling should be avoided; meanwhile, it is recommended to peen the polished chamber, as this will burnish it even further.

**Tumbling**

Another way of deburring and finishing parts is using either rotary or vibratory tumbler. A selected type of media is used, commonly with water and soap, to tumble the parts from few hours to few days to attain desired finish. Aggressive aluminum oxide media can be used to deburr and grind parts faster, but finishing steps should be done with delicate media, such as porcelain. Any tumbler of suitable size will work for the purpose.

It is not recommended to use stainless steel shots or pins for tumbling parts that are made from non-stainless steel. This creates pitting corrosion as stainless alloy is impinged into the base metal through pin peening action, and galvanic corrosion creates small pits, which are a serious risk for cracking and can act as stress raisers, and are extremely detrimental in pressure bearing parts. It is also very difficult to remove the once embedded remains of stainless alloy, as it is less reactive than the base metal, so etching produces little effect and may even escalate the issue. Such parts may be deemed total loss, in worst case. For stainless and nonferrous metals such as brass this problem does not persist.

**Acid etching and electropolishing**

Using acids or electrolysis to deburr and clean parts is an effective method, however delicate control of the process is required to avoid damaging the parts. Acids will generally etch parts at equal rate, however, electrolysis will cause peaks and valleys, which produces uneven result; the effect is measured in micrometers, however, so it may not be a noticeable factor while applying. Electropolishing is much more delicate in terms of pitting corrosion, so if used outside of producing mask etchings described in chapter "Markings", caution must be taken.

Acid etching is most commonly performed either as aggressive pickling phase for crude scale or rust removal, or as a preparative step for plating of finishing. In the former, strong, hot acid solutions such as mixtures of sulfuric and phosphoric acid are commonly used, while in the latter, the surface is merely activated by removing the fine oxidation and impurities layer. A solution of 4% citric acid with soap as detergent at 70-80C for 15min is effective at activating the surface for finishing process.

While applying acids or electrolysis on parts with HRC30 or higher, hydrogen embrittlement may become a factor, and extreme caution must be taken when treating critical parts. The higher the hardness level, the more susceptible the material is for hydrogen embrittlement. With citric acid, there has been no detectable effect, but with strong acids or electrolysis, the materials may even shatter on their own, if not baked after treatment.

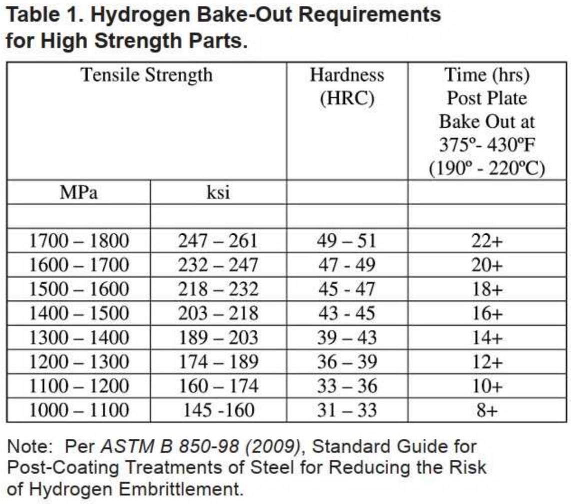


**Table 1. Hydrogen Bake-Out Requirements for High Strength Parts.**

| Tensile Strength | | Hardness (HRC) | Time (hrs) Post Plate Bake Out at 375°- 430°F (190° - 220°C) |
|---|---|---|---|
| MPa | ksi | | |
| | | | |
| 1700 – 1800 | 247 – 261 | 49 – 51 | 22+ |
| 1600 – 1700 | 232 – 247 | 47 - 49 | 20+ |
| 1500 – 1600 | 218 – 232 | 45 - 47 | 18+ |
| 1400 – 1500 | 203 – 218 | 43 - 45 | 16+ |
| 1300 – 1400 | 189 – 203 | 39 – 43 | 14+ |
| 1200 – 1300 | 174 – 189 | 36 – 39 | 12+ |
| 1100 – 1200 | 160 – 174 | 33 – 36 | 10+ |
| 1000 – 1100 | 145 -160 | 31 – 33 | 8+ |

Note: Per *ASTM B 850-98 (2009)*, Standard Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement.

The parts should be baked within 1-2 hours after first possible moment of exposure in order to prevent embrittlement process to begin.

Shot peening

Shot peening has a major effect on parts durability, and in case a part features critical shoulders and stress raisers or is subjected to large cyclic stresses, shot peening should never be skipped. Shot peening can increase parts live by order of magnitude, an example injector part for comparison had to be replaced after only 20k cycles, while a shot peened iteration lasted over a million cycles.

The shot peening is always the last mechanical step performed on a part, and no other work must be done to retain the desired properties. Parts that are peened can be surface finished with passivation or plating without affecting the effect.

Shot peening works by causing yielding and compressive stress to the surface of a part, essentially flattening all cracks, sharp edges and imperfections and creating a microcratered surface. This effectively prevents stress crack formation, which is a major cause for premature parts failure. In gun parts, pressure bearing elements such as locking devices and bolt lugs are commonly shot peened. While the exact method of peening will vary depending on parts and geometry, a basic procedure is to use glass or steel shots of 0.1-2mm in diameter, depending on minimum part feature size, generally preferring the smaller end, at pressures of 2-3bar maximum. The whole surface is thoroughly peened on desired areas to attain the desired effect. While ideal angles and coverage data exists, manual shot peening will gain 50-90% of specialized shot peening effects so even a mediocre peening procedure will improve parts a lot. Shot peening can also double as a surface blasting and cleaning method, although the primary purpose is to form surface stress, so the parts can be abrasive blasted prior peening for maximum effect for both.

In pistol slides, all sharp corners and breech area can be shot peened, however, this process is more critical for geometries commonly faced in rotating bolt weapons and similar, so shot peening is not necessary for Glock manufacturing.

## Final surface treatment: plating and passivation

Surface finishing is commonly the very final step in parts production, where a functional and/or decorative finish is applied. There are countless methods for finishing, however, their application may vary from readily accessible to proprietary supplier products, which are hard to acquire and usually prohibitively expensive.

### Hot bluing

# 11. Finishing

Likely the most basic method for finishing is hot bluing. It is a method of oxidizing ferrous metal surface to form a protective layer from the metal's own base material. For iron, the red oxide, known as rust, occupies larger volume than the base metal, so it will expand and flake off, but black oxide does not, hence it produces similar protective layer than anodized aluminum, stainless steel, titanium, etc. Bluing, when properly done, will produce a protective coating that can be scraped with wire brush without scratching it; however, the layer thickness is in order of a micron or so, and if applied on soft base material, it offers basically no enhanced resistance to abrasion or scratches of any kind.

Stainless steels and high alloy steels such as nickel steels like 4340 are not generally suitable for bluing. 4140 can be readily blued, as can any carbon steels.

This is done by boiling it in a mixture of oxidizer and a strong base. The basic formula is:

- 65 parts of sodium or potassium hydroxide
- 35 parts of potassium or sodium nitrate ($KNO_3$ or $NaNO_3$)

It is, however, noteworthy that the ratio is not critical by any means, and this ratio will produce the fastest and most effective bluing; for personal use, a much more diluted solution will do the same result over a protracted soaking.

Using **ammonium nitrate is NOT** recommended, unless the initial mixing and boiling of first 15 minutes can be done outdoors or using proprietary fume hood, because equimolar amount of ammonia gas is formed upon mixing. Ammonia is basically a gaseous form of lye, being equally corrosive, and it has an extremely pungent odor and it is also toxic due to it's corrosiveness. In case it is used, the resulting product will be sodium or potassium nitrate, and the equimolar amount of hydroxide is consumed in the reaction, hence a larger amount of hydroxide is necessary.

The reagents must be of reasonable purity. $NaOH$ can usually be acquired as pure granules in drain cleaner or soap making products, but sourcing pure nitrates may be a more challenging task. Potassium nitrate is the choice if recrystallization is required, because it has high solubility in hot water, but low solubility when cold, so it allows easy recrystallization and removing of both insoluble and soluble impurities through filtering and decanting. A typical route for accessing $KNO_3$ under oppressive regimes is to acquire calcium ammonium nitrate and mixing it with potassium chloride, and crystallizing out $KNO_3$.

In a stainless steel vessel large enough to fit all the parts, about equal weight of water is added over the $KNO_3$, and carefully, $NaOH$ granules are added, while stirring, to avoid overheating. The solution will heat upon this addition even up to near boiling without any additional heating. The soapy sludge solution is heated, and will clear up, and if necessary, water evaporated by boiling until temperature reaches 150C. If more water needs to be added, extra caution must be taken, because the temperature difference will cause violent splashing. All parts must be fully submerged.

## Bluing process

Parts need to be degreased and cleaned and etched to allow smooth and uniform bluing to form. For this purpose, total of 3 batches are prepared, and a source of running water is kept at hand, or a large volume of clean water. The degreasing bath is 5% lye solution, and the second bath is 4% citric acid and a squirt or two per liter of diswashing soap. Third bath is pure boiling hot water, ideally distilled if tap water is too hard; part is rinsed under hot tap water prior application to prevent cross contamination.

The parts must be prepared prior by removing any traces of coating, paint, scale or other foreign material, as pure, clean and active base metal surface is needed for the bluing to form. Hence the parts must be either tumble deburred and cleaned, or sandblasted. Any solid residues are rinsed off.

The parts can be based either into a steel mesh basket of available type, or attached to a pure steel or stainless wire (non-galvanized), so they can be lowered into each bath without touching the surfaces of the vessel to prevent spot formation.

# 11. Finishing

The supported parts are boiled in lye bath for 5 minutes. After this, the parts are transferred to the citric acid bath, and kept for 5-10 minutes. Then the parts are rinsed with hot water.

Then, the parts are transferred at once into the bluing bath by carefully immersing them fully into the liquid. Part immersion time is between 30 to 60 minutes for full black finish to form.

After soak, parts are transferred into hot clean boiling water bath, and boiled for 5-10 minutes. From here, parts are soaked with water dispersing oil. After cooling, the parts can be sealed in a ziploc bag with enough W.D to spread to every surface. The parts are soaked in preferably overnight.

After this, the parts are scrubbed with brush, for example toothbrush, to remove any loose deposits, and wiped clean. Treat parts with light gun oil according to recommendations.

If the bluing finish has spots or is not satisfactory, it can be reversed easily by degreasing, and acid etching the surface, which will quickly remove the oxide layer, and the parts can be re-blued right away.

When bluing barrels, the bore is generally left as is, as plugging it will cause pressure buildup in high temperatures and may cause violent splashing of the hot caustic bath when the end plugs blow off. Bluing will only create a surface layer of few microns in thickness at most, so it will have no effect on bore tolernaces on home workshop or service grade weapons.

The bluing solution will turn into white or tinted sludge after use when cooled to room temperature, and is good and ready to be used when stored in a bucket with a lid or in a canister. Over time, hydroxides will react with atmospheric carbon dioxide, forming carbonates, which will eventually cause spotting, but these solid residues can be removed by pouring the solution through a very fine steel mesh filter. Over time, more nitrate and caustic needs to be added, however properly stored and used solution will keep good for several uses and has an infinite shelf life.

**Parkerizing**

Parkerizing, or manganese phosphatizing is a passivation process where a solution consisting of manganese source with phosphoric acid is used to convert the surface of a steel part into porous, crystalline layer of manganese phosphate, which is durable and readily absorbs and retains oil, hence protecting the parts from corrosion to a great extent, and also providing aesthetic matte finish surface.

The common recipe involves phosphoric acid and manganese dioxide, as they are easily available as rust removal or cleansing products and extracting from D-batteries, however, $MnO_2$ does not readily react with phosphoric acid, and the resulting coating will consist mostly of iron phosphate, which appears deep black, but is easily wiped off and offers very limited protection.

Hence, it is important to use a reactive form of manganese, most accessible being manganese carbonate. In this chapter, two ways are described: a simple, two-ingredient bath, that produces basic parkerized surface with variable results, and an actual, industrially used formula, which involves more active ingredients, but is much more consistent and provides better performance and finish.

Any stainless steel, glass or teflon coated vessel can be used for the process. Process temperature is 95C and reaction time is usually around 15-20 minutes. Surface preparation is critical for successful parkerizing, and ideal method is to degrease and clean off any debris, dry, and sandblast the parts, and then perform acid etching using 15% HCl or $H_2SO_4$ solution, optionally with up to 10mL/L of 3% $H_2O_2$ as a catalyst for 3min at room temp. Another option is to use citric acid bath with 5% citric acid and liquid soap at 70-80C for 5min. After this, parts are rinsed thoroughly, washed with distilled water, and phosphatized.

**Parkerizing, simple method**

For simple parkerizing solution, the ratio of ingredients is following:

- 4000 parts of pure water

- 134 parts of manganese carbonate
- 118 parts of phosphoric acid (85%, calculate dilution if necessary)

The reactants are mixed to the water, and simmered to allow for all of the manganese to react, some residue may remain. Reaction time can be expected to be 1-2 hours. After this period, piece of degreased, clean steel wool size of matchbox can be applied as an activator.

Parts are dipped in solution using steel wire (remove possible zinc coating with acid before use), and phosphatized commonly for 15-20 minutes at 95C, however the reaction time may vary slightly. After reaction is complete, parts are rinsed thoroughly with hot water, dripped dry from excess water, and soaked with water displacing oil.

**Parkerizing, full method**

The process run for full method is the same, however a more diverse range of reactants is used for the bath:

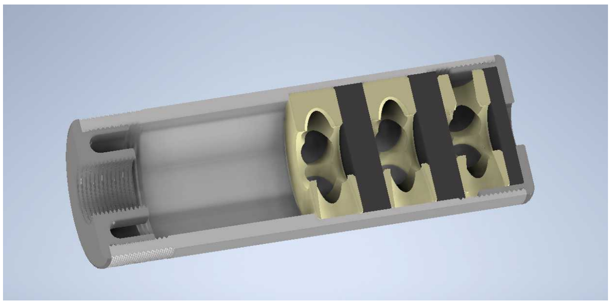
For 3 liters of water:

| | |
|---|---|
| Phosphoric acid (85%) | 42g |
| Manganese phosphate | 90g |
| Manganese nitrate | 36g |
| Manganese carbonate | 3g |
| Nickel nitrate | 1.8g |

This formula will provide more durable and corrosion resistant parkerized surface.

Parkerizing solutions will remain good for several uses, and in case the reaction rate seems to slow down, more phosphoric acid can be added in small amounts. The solid residues will settle to the bottom when the solution is cooled, and can be generally easily decanted off when moving the solution to storage container.

# 12. Suppressor



**TO BE FNISHED**

**Extra chapter: compact wiped suppressor**

Due to gunshot sound being so readily distinguishable and far-reaching, it was deemed mandatory to include an effective suppressor with the G19R package. The suppressor is based on Hush Puppy – design, which incorporates compact size, use of wipes and oil, light weight and no need for Nielsen Device. This suppressor will last about one magazine of shooting until it starts to lose it's effectiveness to a significant degree, and remains effective for concealing readily distinguishable gunshot sound up to two or even three magazines of rounds.

As tilting barrel pistols cycle, the barrel and slide will travel together about 3mm backwards, until they separate, extra weight may cause the barrel-slide pair to not gain enough momentum to fully cycle the gun, so a Nielsen device, that is a spring loaded piston collar, is required to allow this impulse to occur, is required. This suppressor weights around 100 grams, and is hence well suited for semi-automatic pistols without this device.

The basic structure features an aluminum tube with steel endplates, 3D printed polycarbonate or nylon spacers, and rubber wipes. Half of the internal diameter is turned larger, and M24 and m27 by 1mm threads are formed for endcaps, and muzzle thread can be left at the user's choice, here 1/2" x 28 TPI is used.

Use of the suppressor

Do NOT use hollow point bullets. Only subsonic rounds must be used for the suppressor to be effective.

Apply vaseline or viscous oil to suppressor before assembling. The purpose of the oil is to absorb heat from combustion gases.

# 13. Technicals

In this chapter information regarding general metalworking, materials, strength calculations, heat treatment and other data is presented that are necessary in gunsmithing.

To be finished